THE
Malayan Agricultural Journal
OCTOBER, 1950

EDITORIAL

Cocoa. Three of the four original articles in this issue of the Journal deal with the work of the Department in connection with the introduction of cocoa as a crop in Malaya.

The article by Mr. Rosenquist describes the work carried out to date by the Department on the selection and breeding of cocoa, wherein the aim has been to assemble as wide a range as possible of material, for observation in the first instance, and for selection and breeding later. The material under observation includes Trinitario, Amelonado and Criollo types from sources both local and overseas. The three types are being compared as to their suitability for planting in Malaya while a commencement has been made with selection and breeding of the Trinitario and Criollo types. It is obvious that if a cocoa industry is to be established on a sound basis in this country, the best possible planting material must be made available in as short a time as possible; hence the importance of the work described in this article.

The second of these articles, by Mr. Berwick, deals with further investigations into the growing of cocoa in Malaya. This supplements the information given by Mr. Hartley in an article on similar lines in the April, 1949 number of this journal. A comprehensive series of field experiments is being carried out both on Agricultural Stations and in co-operation with estates and smallholders to test various methods of establishing cocoa, both in the nursery and in the field, and the work has now reached a stage where certain interim conclusions are possible, both as regards propagation methods and establishment in the field. This work on the agronomic aspects of cocoa cultivation is complementary to the work on selection and breeding described in the first article and is of equal importance to the future of the cocoa industry in this country.

The third article in this series on cocoa, by Mr. Thompson, gives an account of the introduction of Amelonado cocoa from the Gold Coast for trial in Malaya. This introduction was carried out on the recommendation of the Cocoa Research Sub-Committee of the Colonial Committee for Agricultural, Animal Health and Forestry Research and the whole operation including the provision of nursery facilities in Malaya was financed from Colonial Development and Welfare funds. The Amelonado type forms the basis of the West African cocoa industry and thus of the greater part of the world's supply of commercial cocoa. It was not present in Malaya prior to this introduction. Very considerable precautions were necessary in con-

nection with the introduction owing to the danger of importing into Malaya the "swollen shoot" virus, which has caused so much damage in the cocoa areas of West Africa, and other dangerous pests and diseases. The successful transfer of the cocoa seed by air from the Gold Coast to Singapore and the subsequent growing of the plants in an isolation nursery on Pulau Tekong Besar, an island near Singapore, were only made possible by a very considerable degree of organisation, with the full co-operation of the West African Cacao Research Institute and a number of other bodies, and the most thorough supervision on the part of the author of the article.

Pasture Establishment.

One of the primary essentials for the extension of cattle and buffalo raising in Malaya is the provision of better quality grazing than is now generally available.

A second article by Mr. Rosenquist describes one of a series of experiments now being carried out at the Federal Experiment Station, Serdang. These experiments are designed to provide information on ways and means of improving the quality of pastures in Malaya. The results obtained to date from the series as a whole may be described as extremely promising.

Original Articles.

COCOA SELECTION AND BREEDING IN MALAYA

BY

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Botanist.

The policy of the Department of Agriculture has always been directed towards diversification of economic crops in Malaya, but for many years rubber *(Hevea brasiliensis)* has been such an easy, sound and remunerative crop that little opportunity has been found for much practical application of this policy.

Malaya has been considered, for a long time, as a suitable country, climatically, for growing cocoa trees, but pre-war predominence of the more easily produced rubber crop, as stated above, and the fulfilment by other countries of the demands of even an expanding market for cocoa have precluded much active interest being shown in this crop in Malaya.

Since the 1939-45 war, however, as a result of the more serious threat from manufacture of synthetic rubbers, interest in and opportunity for diversification of agriculture has greatly improved, and given opportunity for re-emphasis of this policy of diversification, as is shown in the Annual Report of the Department of Agriculture for 1949. (1)

Co-incident with this development, serious disease of cocoa trees in West Africa has threatened a great decrease in the cocoa crops from that country, and in consequence has greatly improved the economic possibilities of establishing cocoa successfully in Malaya.

Cocoa therefore received especial attention after the war as a possible alternative crop, and the Department of Agriculture cocoa experimental plots, which had been planted between 1923 and 1938, provided the first material for study. Recording of individual tree crops was commenced at the Federal Experiment Station, Serdang, in 1947, and at the Cheras and Temerloh Agricultural Stations in 1948. In addition, officers of the Field Branch of the Department made a survey of cocoa trees growing in Malay and Chinese kampongs (villages) throughout the peninsula.

Prof. E. E. Cheesman, formerly of Trinidad, visited Malaya, Borneo and Sarawak during the period December, 1947, to March 1948, at the request of the Malayan and other Governments, to investigate the cultural possibilities of the economic development of cocoa growing. His report was published in 1948. (2)

Following upon the recommendations of this Report, cocoa establishment trials and selection work were extended, and the need for and problems of introduction of varieties and types of cocoa from abroad were examined.

The author arrived in Malaya in January 1949, and took over the cocoa selection work which had been started by the Senior Botanist in July, 1948. Breeding work was commenced as soon as adequate selection records were available.

Articles on certain aspects of the work on the establishment of cocoa in Malaya have already been published (3 and 4) and it is intended that this article should be an introduction to the various aspects of breeding and selection which are in progress.

General Policy.

In view of the real danger of importing serious diseases from the principal cocoa growing countries, it was decided that bulk imports of seed could not be adequately quarantined. (5). Further it was felt that cocoa selected in the West Indies, West Africa or elsewhere would not necessarily be adapted to Malayan conditions. It was therefore decided that the bulk import of seed for commercial planting was not in the best interests of a potential cocoa industry in Malaya.

It was also decided that the import of even small quantities of budwood was not justified because of the risk of introducing virus diseases (which may be carried in the symptomless stage and hence fail to be detected in quarantine).

If the industry is to be established on a sound basis the best possible planting material must, however, be made available quickly. To this end the selection and breeding of locally available material was commenced. Certain imports of selected types of cocoa have also been made and further small imports are being arranged. These imports are restricted in size to facilitate efficient quarantine. The object of the imports is to test, under Malayan conditions, the best material that can be obtained from other countries and, ultimately, to multiply those which prove themselves suited to Malayan conditions.

At present, most of the cocoa being planted is experimental and designed to determine the best methods of establishing the crop in Malaya, (4).

Large scale commercial planting is not expected to start until these agronomic experiments on methods of establishment have shown conclusive results. It is hoped that by the time it is possible to start large scale planting, some form of proved planting material will be available.

Before discussing the selection and breeding work which has been started, something must be said of the previous imports of cocoa seed into Malaya to show the range of material available for selection locally.

Imports of Cocoa Seeds Into Malaya.

The history of early attempts to grow cocoa in Malaya has been summarised by Burkill (6). As some trees remain from these early introductions it is of interest to know where the seed came from.

The earliest record of cocoa in Malaya is in 1778, when a tree was growing and fruiting in Malacca (7). In 1802, cocoa was recorded from Penang, and in 1823 from Singapore. The origin and type of these imports is not known. Criollo cocoa is now widely distributed throughout Malaya, although there are probably only about 1,000 mature trees altogether. These are in small groups and rarely are there more than four

or five trees in one group. It is suggested that some of these trees may be the progeny of the very early imports.

Imports confirmed as coming from Ceylon are fairly frequent. In 1880, Cantley is stated to have imported 'races of Trinidad' from Ceylon (8). It seems possible that some of these were planted on an estate at Bukit Ibul near Port Dickson in Negri Sembilan. Although these trees came into bearing the estate was replanted with rubber. The progeny of some trees from Bukit Ibul are growing at Tanah Datar in Negri Sembilan..

Again, in 1923, the Department of Agriculture imported Forastero and Nicaraguan varieties from Ceylon (9). It is thought that a few trees from this importation, and a fair number of their progeny, survive on the Agricultural Stations at Temerloh and Kuala Lipis in Pahang.

About 1928, a villager at Trong, North Perak, received some cocoa seed from a friend in Ceylon, and a number of the trees raised from this seed survive in that neighbourhood.

A plot of Trinitario cocoa was planted at the Federal Experimental Station, Serdang, in 1934, using seed from a vigorous and freely fruiting tree growing locally near Klang (10). This tree was stated to be of Ceylonese origin.

A number of the seedlings planted at Serdang died. Replacements were obtained by raising seedlings from two pods imported from Peradiniya, Ceylon.

Imports of seed from other sources, which are not so well substantiated, are from Java to kampongs on the Sungei Perak, from Borneo to Beranang (Selangor), from Medan (Sumatra) to Dusun Tua (Selangor). Surviving trees, or their progeny, from these imports have been located.

Since the recent revival of interest in cocoa growing, an import of selected material has been made from Ceylon (4). This import, of the Trinitario type, was made in 1946 and some 15,000 seedlings were obtained. Some of these have now begun to fruit on various estates.

In 1949, an isolation nursery was established at Pulau Tekong, an island off Singapore. (1). An import of some 5,000 seed of West African Amelonado cocoa from the Gold Coast was then made and some 3,000 seedlings raised.

A few hundred seedlings of selected material from Java have recently passed through this nursery. It is hoped that further selected material from other sources, including Samoa and W. Africa, will be received shortly.

Selection and Breeding.

The selection and breeding programme is concentrating on (a) Trinitario cocoa, (b) Criollo cocoa and (c) West African Amelonado cocoa. The three types are being compared in trials, and simultaneously legitimate and illegitimate progenies of the first two types are being tested. The work in progress on each of these three types will be described.

(a) Trinitario Cocoa.

Introduction.

The Trinitario complex contains a mixture of various types of cocoa ranging from near-Criollo to a Forastero type. Although the complex contains some trees of outstanding performance there are also many inferior trees. The individual trees themselves are usually heterozygous and do not, in general, breed true. Consequently the only safe way of propagating the good trees is vegetatively. A programme of clonal selection has therefore been started.

The size of the population at present available is so small that the chances of isolating a first class clone are poor. The population is being expanded as quickly as possible. Nearly all seed produced is being planted in agronomic experiments of various types. The trees selected for inclusion in the clonal trials will have their progenies tested in a breeding programme. The progeny trials will indicate which are the best parents for future breeding and for the production of clonal seed for distribution.

Records.

Yield records of all the Trinitario cocoa trees on Departmental Stations are being kept. These comprise principally the ½ acre plots at Serdang and Cheras, and the plots at Temerloh and Kuala Lipis. Some of the imported Trinitario cocoa from Ceylon (1946) is also being made available for selection during the next few years.

The disturbed state of the country and pressure of work have confined detailed work to Serdang and Cheras.

Serdang.

The plot at Serdang was established in 1934, and an account of the establishment has been given by Faulkner and Milsum (10). The trees are mostly the progeny of the single isolated tree which was found fruiting freely near Klang. To provide supplies, two Forastero pods were imported from Ceylon (as mentioned above). Some of the records were lost during the war and it is not now known which are the trees originating from Klang or which came from Ceylon.

The plot is harvested weekly and the following individual tree records are kept:—number of pods, weight of pods, weight of wet cocoa, number of good beans per pod and the colour of the beans. The compatibility of the trees has been determined using the technique described below. Only 14 of the 42 trees tested are self-compatible. Seven trees from this plot have been selected. The plot is being invaded by red root disease (*Ganoderma pseudoferrum*), and now only 40 trees from an original 108 remain outside the infected area.

Cheras.

The plot at Cheras was planted in 1937. The seed used was open pollinated seed from two of the Serdang trees, the bulk of the plot being the illegitimate progeny of Serdang 41, and the remainder of Serdang 34,

Table I.

Summary of Yield Records, 1948 and 1949, of Selected Cocoa Trees at the Federal Experiment Station, Serdang and Cheras Agricultural Station.

Parent Tree	Yield of pods (2 year total, 1948 & 1949)	Mean pod weight 1949	Mean weight of beans per pod.	Estimated pod value (No. of pods to give 1 lb. of dry cocoa)	Bean size (No. of wet beans per lb.)	Compatibility
		lbs.	grms.			
Serdang						
S3	96	.79	90	12.4	144.7	SC
S4	166	.86	84	13.2	132.7	SI
S15	124	1.19	130	8.7	107.7	SI
S24	86	.89	92	12.1	118.7	SI
S27	127	1.02	91	12.3	142.5	SI
S41	77	1.11	108	10.2	105.6	SI
S47	102	.76	82	13.7	132.2	SI
Cheras				(Small samples only)		
C2	262	.91	66	17.1	132.6	SC
C7	266	.90	108	10.2	126.8	SC
C13	216	1.03	70	16.2	129.0	SI
C18	240	1.24	98	11.6	117.9	SI
C41	116	.91	94*	11.9*	150.9*	SC
C50	180	1.01	52	21.6	137.3	SC
C56	142	1.17	125	9.2	103.6	SI
C75	122	.86	67	17.0	156.7	SC
C84	294	.82	89	12.6	109.9	SI
C88	125	1.47	97	11.6	129.3	SI
C129	184	.89	49*	22.8*	149.7*	SC
C131	211	.91	89	12.6	112.7	SI
C137	226	.72	—	—	—	SC

SC = Self—compatible

SI = Self—Incompatible

* = Estimates from very small samples.

which is now dead. These two trees were selected in 1937, when only about three years old, on their yield records and the records of bean size then available. There are now 151 mature trees at Cheras.

As the seed from Cheras is being despatched in the pod for use in agronomic trials, it has only been possible to record the number and weight of pods from each tree. Samples of pods from 13 selected trees have, however, been fully recorded.

Table I summarises the 1948-1949 records of the 20 selected trees at Serdang and Cheras.

Testing for Compatibility.

Trinitario cocoa exhibits a rather unusual type of sterility mechanism which is not as yet fully understood. Self-compatible (or self-fertile) trees will effectively pollinate all other Trintario cocoa trees. Self-incompatible (or self-sterile) trees are not only self-sterile but fail to pollinate each other (11).

Table II illustrates some results obtained at Serdang. Freshly opened flowers on various trees were hand-pollinated. The flowers were not protected in any way from extraneous pollen. Provided one parent was self-compatible, sets were obtained from 60 to 80 per cent. of the flowers pollinated. If both parents were self-incompatible, less than 1 per cent. sets were obtained.

Table II.

A Summary of the Results of Hand Pollinations between various classes of Trinitario Cocoa Trees at Serdang, May, 1948.

	Male Parent		
	Self-incompatible	Self-compatible	
Female Parent. Self-incompatible.	213	101	Pollinations
	2	78	Sets
	.93	77	per cent.
Self-compatible.	9	34	Pollinations
	6	28	Sets
	66	82	per cent.

As a result of the figures summarised in Table I, it was decided that the following method of testing for compatibility should be adopted. Ten flowers on the tree are self-pollinated by hand. If, after 14 days, 3 or more sets are observed, the tree is accepted as self-compatible. If no flowers have set, it is classed as self-incompatible. If there are only one or two sets, the test is repeated. This test may be modified under certain

conditions, e.g. when testing very young trees which are thought to give a lower percentage of sets than mature trees.

Clonal Selection.

(i) *Selection of parent trees.*

From the records obtained at Cheras and Serdang, a total of 20 trees have been selected for comparison in clonal trials. The character given greatest importance was yield of wet cocoa. This was known with precision in the case of the Serdang material, and estimated from the available records of Cheras material. Size of bean was considered; it is feared that both the population at Serdang and Cheras, and Temerloh and Kuala Lipis are rather below average in bean size. Self-compatible trees were favoured in preference to self-incompatible, as evidence from Trinidad suggests that, in general, self-compatible clones tend to yield more than self-incompatible clones (12). Moreover, self-incompatible clones are useless if planted in monoclone blocks.

(ii) *Cuttings.*

It was decided that the first clonal trials should be made with fan cuttings. This decision was made in view of the higher yields being obtained from fan cuttings compared with chupon cuttings or buddings in Trinidad. (12 and 15). The technique for striking cuttings closely follows that described by Keeping (3), except that the cheesecloth over the glass frames has been dispensed with.

As the cuttings for the first clonal trial were being taken, various growth-promoting substances were tried to improve rooting. A powdered form ("Seradix B") was finally adopted for general use as being the most convenient and satisfactory of those tried. The cuttings were examined 21 days after being placed in the propagator and again 7 days later. Table III illustrates the results obtained after 21 days using cuttings treated with "Seradix B" and untreated controls.

Table III.

An Extract of the Records Showing the Effect of "Seradix B" (No. 3) on Cocoa Cuttings Examined 21 Days after placing in the Striking Bin.

Treated				Control			
No. of cuttings	Rooted at 21 days	per cent. rooted	Mean No. of roots/cuttings	No. of cuttings	Rooted at 21 days	per cent. rooted	Mean No. of roots/cuttings
12	8	66	—	12	2	17	—
13	3	23	—	13	0	0	—
30	10	33	—	29	3	10	—
41	12	29	5.5	41	6	15	3.0
27	15	55	7.6	27	10	37	2.9
30	7	23	7.1	29	7	24	2.7
13	11	84	6.9	13	8	61	1.6

In the first clonal trial, about 50 per cent. of the cuttings taken survived until planting in the field. About 65 per cent. of the cuttings rooted within four weeks but some 15 per cent. did not survive hardening. Many of the cuttings were too old or too small but were the best that could be obtained from the selected parent trees.

During the period March to June, 1950, in preparation for the second clonal trial, over 700 cuttings were taken and 74 per cent. of these rooted in four weeks. In this case "Seradix B" was used on all the cuttings.

(iii) *Clonal Trials.*

A small clonal trial of ¾ acre was planted in November, 1949, at Serdang. It is hoped that this will give an early indication of the relative merits of the 20 clones represented. In this trial each clone is represented by only 10 fan cuttings (in 5 Blocks with two-tree plots.). The establishment of this trial gave experience in striking cuttings and practical experience in handling cuttings in the field.

In a second clonal trial, 9-tree plots are being used and 18 clones are being compared. The first three blocks have been planted and cuttings are being taken for a further two blocks.

(iv) *Budwood area.*

The clonal trials should make it possible to determine the best three or four clones of the Serdang and Cheras selections. It is anticipated that these clones may be superseded in a few years when selections among the large number of seedlings recently planted can be made. They will however provide improved planting material at a relatively early date.

In order to facilitate the distribution of any clones which may be selected it was decided to establish a budwood area. Part of this area has already been established. Stocks, about 6 to 8 months old, were planted 6 × 4 ft. in well prepared land. Overhead shade of ataps was provided as a temporary measure. The stocks were then budded with clonal budwood. Petioled budwood was used. After a union was established, the stock was bent over, away from the budpatch, and pegged down. There was no difficulty in establishing a living union between the stock and the budpatch but some of the buds were slow to develop. Approximately 70 per cent. of the original buddings have now developed and are growing vigorously. The budding was started early in 1950, and within nine months it has been possible to take a few cuttings.

The general distribution of clonal material will not start until some results from the clonal trials are available.

Breeding.

A number of crosses between selected trees were made at Serdang in April and May, 1949. The pods reached maturity between 160 and 260 days after pollination. As a result of 100 sets, only 31 pods were harvested. Table IV shows the number of cherelles which wilted each month. This heavy loss of cherelles was not at that time anticipated and, as a result, the progenies obtained were too small to justify replicated trials.

Table IV.
Number of Cherelles which Wilted Each Month.

Pollinated April/May 1949 and set.	No. of cherelles which wilted per month						Harvested	Lost*
	May.	June.	July.	Aug.	Sept.	Oct.		
100	19	5	10	27	1	0	31	7

*the loss of 7 cherelles occurred during felling to check *Ganoderma pseudoferrum.*

However, seven of the legitimate progenies were incorporated in a trial to compare (i) West African Amelonado, (ii) local Trinitario (near Criollo) and (iii) local Trinitario (Forastero type). This trial was planted in March, 1950, and comprises 7 blocks, each containing 3 plots of 30 trees. Growth is satisfactory. The West African Amelonado and the local Trinitario (near Criollo) are at present vegetatively more vigorous than the local Trinitario (Forastero).

Further legitimate progenies were incorporated in a trial between local Trinitario and local kampong Criollo. This trial is planted in jungle rentices and comprises four blocks, each containing two plots of about 150 trees. This was planted in September, 1950.

In April and May, 1950, a further and more ambitious series of selfs and crosses were made on selected trees. Most of these were at Cheras. All the self-compatible trees were selfed and each self-incompatible tree was crossed with one or more self-compatibles. The female flower was not protected in these cases.

A number of crosses were made between self-compatible trees. There were many ants on the trees and it has been shown that ants are effective agents for carrying pollen from one flower to another on the same tree (13). When crosses between self-compatible trees were made, the female flower was protected in the following way: a ring of plasticine was placed round the flower the day before it opened, a glass tube, 1 in. in diameter and 1½ ins. long, was seated into this plasticine and a piece of fine muslin was held over the end of the glass tube by an elastic band. This arrangement effectively prevented the ingress of insects but allowed the flower to be inspected. The tube was removed two or three days after hand pollination. This technique originated in Trinidad and is in routine use in West Africa.

From the selfs and crosses made, it is hoped to raise about 30 progenies of 100 seedlings each. The pods are now being harvested and a site has been prepared so that these progenies can be planted in March, 1951.

Future Work on Trinitario Cocoa.

The material from Cheras and Serdang (now only 200 trees) has been fairly exhaustively surveyed. It is hoped to carry out a similar

selection programme for Temerloh and Kuala Lipis. Some of the material imported from Ceylon in 1946 has also been made available for selection. Meanwhile, all the plots planted with unselected seed from Cheras and Serdang in the last two years will come into bearing soon and give a further population for selection. Further, the few Trinitario trees growing in the kampongs have been assembled as buddings and will be observed.

As this larger population becomes available for selection, there will be better chances of finding good material.

(b) Criollo Cocoa.

Introduction.

Although Criollo cocoa is not now extensively used as a commercial crop it was decided that the local material growing in the kampongs deserved investigation. Criollo cocoa has exceptional quality and even if the type is never used commercially in Malaya it may be valuable for breeding purposes. Trees which have survived generations of neglect in the kampongs may be hardy and well adapted to local conditions.

The selection of trees growing in the kampongs is almost impossible owing to the lack of uniformity in conditions. In general, one or two of the most promising trees in each locality were chosen. Having 'selected' the trees, budwood and seed were collected; the budwood was budded onto stocks at Serdang to preserve the parental type. The seed will be tested in progeny trials. If any of the progenies are promising it will be possible to obtain further similar progenies by taking seed from the appropriate budding at Serdang.

Unfortunately most of the kampong Criollo produces small beans. The pods are somewhat similar to the Costa Rican type.

Criollo Buddings.

Trinitario stocks in the field, with an average age of about 2 years, were made available for the Criollo buds. Budwood was collected from the kampong trees but was not petioled. The budwood was waxed, kept moist and brought to Serdang. The buds were grafted onto stock in the normal way. After a living union had been established, the stock was ring-barked a few inches above the bud. The stocks in this case were too large to bend over. Results were irregular. In July, 1950, from 932 buddings a living union was established in 471. (50.5 per cent.). Of these 471, only 219 (46.5 per cent.) had begun to develop. Thus, only 23.4 per cent. of the original buddings have so far developed. More buds are still shooting and dead buds are being replaced. A number of the stocks are dying as a result of the ring barking and it is hoped that a better method of budding in the field will be found. It is possible that the unsatisfactory nature of the budwood on the kampong trees is the main obstacle to greater success.

Approximately 80 Criollo trees have been selected and most of them are now represented by at least one budding at Serdang. Each selection was originally budded onto nine stocks. This collection or Criollo buddings is being completed.

Criollo Seedlings.

Some difficulty has been experienced in harvesting mature pods in the kampongs. The trees are usually in small, isolated groups and squirrels do much damage to nearly mature pods. Some progress has however been made and it is hoped to plant 36 illegitimate progenies, each comprising 72 seedlings, during the next few months. These seedlings are now in baskets and a site is being prepared. It is not proposed to add to this trial at present.

A number of illegitimate Criollo progenies have also been incorporated in a trial with local Trinitario as described above.

Botanical Notes.

There appears to be little self-sterility in the Criollo cocoa. Sufficient evidence is not yet available to estimate the exact position. It is also thought that the Criollo population may contain relatively homozygous trees which will produce uniform progenies. If this is so, then commercial propagation may be by seed rather than by vegetative means.

During the survey of Criollo cocoa a rather interesting type was found. This was similar in most respects to the other Criollo trees but had a green pod and a creamy-white flower, with no trace of pigmentation The flowers seem to be similar to those found on a mutant of *Theobroma leiocarpa* and described by Miranda and Silva in Brazil (14). This white-flowered type, about 15 trees in all, was found in Malacca, Perak, Kedah and Perlis. It is represented in the collection for further study.

(c) Amelonado Cocoa.

Although West African Amelonado Cocoa is the major type in the world market it has not previously been introduced to Malaya. An import from the Gold Coast was therefore arranged. Mr. Thompson, the Senior Plant Pathologist of the Department, was in charge of this importation. An article by Mr. Thompson describing this importation appears elsewhere in this issue of the Journal.

West African Amelonado cocoa has been planted in an isolation block, 3 acres in area, for multiplication purposes; the young trees are growing well. As mentioned previously, a further 210 seedlings were planted in a trial with legitimate Trinitario progenies.

On eight different sites throughout Malaya, trials have been planted to compare (i) Amelonado,

(ii) illegitimate progenies of selected local Trinitario trees and

(iii) unselected local Trinitario seed.

In this way it is hoped to multiply the Amelonado seed for future use and to get some indication of its performance in relation to local Trinitario under Malayan conditions.

There is no sterility in West African Amelonado cocoa and it is sufficiently homozygous to be propagated commercially by seed. If this type is planted in Malaya, it is unlikely that it will be necessary to use vegetative propagation. Even selection within this type is not at present envisaged.

Discussion.

The general aim has been to assemble, at the Federal Experiment Station, Serdang, a wide range of cocoa types for observation. It is proposed that this policy should be pursued by arranging further small importations of various types of cocoa.

The Trinitario, Amelonado and Criollo types are being compared to assess their suitability for planting in Malaya.

Within the Trinitario and Criollo types a start has been made on selection and breeding.

The future programme will be dependant to a large extent on the results of the various trials which have been planted or planned for early planting.

Cheesman, in his report, (2) made certain general recommendations with regard to the supply of planting material for a potential cocoa industry, and the majority of these recommendations are being implemented in the way described.

Summary.

The origin of the Cocoa trees in Malaya is briefly outlined, and the comparative trials and the selection and breeding work in progress are described.

Acknowledgements.

The author is responsible for carrying out the botanical side of these investigations. Most of the work involved in the nurseries, preparation of planting sites, and routine maintenance in the field has been done by officers of the Agronomy Division of the Department at the Federal Experiment Station, Serdang. Officers of the Field Branch of the Department were responsible for locating the Criollo cocoa in the kampongs. I wish, therefore, to acknowledge with thanks the co-operative help of all these officers. I wish also to acknowledge the guidance and advice received from Mr. O. J. Voelcker, C.B.E., the Director of Agriculture, Federation of Malaya.

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FURTHER INVESTIGATIONS INTO THE GROWING OF COCOA IN MALAYA

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Introduction.

Hartley in a previous article in this Journal (4) has described trials in the establishment of cocoa to be conducted on both estates and Agricultural Stations. The methods used were based on the recommendations in the report by Professor Cheesman on the potentialities for the cultivation of cocoa in Malaya (1) and followed the traditional system which had been found to be successful in older cocoa-growing countries, such as the West Indies. This system consisted essentially of the planting of cocoa seedlings, well established in baskets, into a planting hole filled with jungle soil or a mixture of soil and cattle manure, in a cleared area on which primary (initial), secondary (temporary) and tertiary (permanent) shades were grown. In the Malayan trials, the normal primary shades were herbaceous covers such as *Tephrosia spp., Crotalaria spp., Leucaena glauca* or *Cajanus indicus*; the secondary shades were bananas or *Gliricidia*; and the tertiary shades consisted of leguminous trees such as *Enterolobium saman, Peltophorum ferrugineum, Parkia spp.*, or the *Albizzia spp.* It was considered that this method would ensure that the best possible chance would be given to the small quantity of seed available so that planting material would be increased as rapidly as possible. It was soon found, however, that, in Malaya, this system suffered in many instances from two disadvantages; the first was that the cocoa tended to be attacked by several pests, the most important being night-flying cockchafers, such as *Apogonia* and other species, and mealybugs; the second was the large financial outlay required. That the establishment of a new crop by planters inexperienced in that crop will be expensive is to be expected, but in this case the amount involved was so large that the prospects of establishing a cocoa industry, if the crop proved to grow successfully, were endangered. More recent trials, therefore, have been designed with the object of preventing insect attack as far as possible and decreasing the cost of establishment.

The criteria on which these trials will finally be judged will be their success in raising healthy trees, coming into bearing at an early age, and producing seed urgently required for extension of the industry, subject to the genetic variation characteristic of Trinitario cocoa and the need for selection amongst them. To some extent therefore, a report on the trials may be thought premature. The Department of Agriculture, however, is constantly being asked what is the best method of planting cocoa in Malaya. It is obviously unable to reply definitely to this question until sufficient trials reach their final stage, but observations on the trials already conducted have made it possible for the Department to suggest several possible

methods by which cocoa might be established and to indicate ways by which they might be satisfactorily tested. The object of this article, therefore, is to describe the various methods which are being tried and to give the results of observations which have already been made; these include measurements of height and girth which, as experience with other similar crops has shown, will almost certainly be correlated with yield.

The Terms Used in connection with Cocoa Cultivation.

Cocoa grows in a peculiar way and so the terms used to describe branching and habit of growth in the case of more normal trees cannot be used. Special terms must, therefore, be used and, as the growing of cocoa as a crop originated in Spanish America, most of the terms are derived from Spanish.

A typical cocoa bush, growing in ideal conditions and free from pest or disease attack, will produce a straight vertical stem to a height of from 3 to 7 ft., the height depending largely on its genetical make-up. At this height, further direct vertical growth ceases and a series of branches growing more or less horizontally is produced. These branches are known as fans, and the point at which they arise is called the 'jorquette'. Further vertical growth then takes place from just below the jorquette, the stem being called a 'chupon.' This chupon in turn will jorquette to form a further series of fan branches, and in this way the cocoa bush will grow in tiers, a mature bush being composed of 3 to 5 tiers. Plate 1 shows a young cocoa bush with two jorquettes.

When the bush is growing in conditions which are not ideal or when it is damaged by pests, it tends to produce more chupons lower down the stem, and a multiple-stemmed bush is produced. Such a tree is shown in Plate II but it must be emphasised that such growth is not normal and that, if it does occur, excess stem suckering should be controlled by pruning.

The Methods Used in the Cultivation Trials.

It would have been ideal to conduct all the necessary trials on Agricultural Stations, where supervision and recording can be most satisfactorily carried out, but due to lack of staff, suitable sites and funds, this has been possible only in a few localities, and the rest of the trials were conducted co-operatively on estates or on smallholders' land. This had the advantage that more people became experienced in the planting of cocoa but it also had great disadvantages, namely, that the general programme had to be built up piecemeal as opportunity occurred, that supervision was in many instances inadequate and the trials did not, in fact, test the particular points for which they were designed, and that recording was not done as accurately or regularly as was desired. The Department coped with as many of the trials as it could and when an estate or smallholder asked for planting material, this was given on the understanding that a trial would be conducted; the area was then inspected and a suitable trial, which had its place in the general programme, was designed.

Many of the trials took the form of observation plots, that is to say, they were not replicated, each treatment being tested on one plot only. This has its limitations in that any measurable results which can be obtained cannot be analysed for significance statistically, but it is justified on the grounds of ease of supervision, and by the fact that, at the present stage in cocoa investigations, interest is focussed on large differences, in many cases in the success or failure of establishment. When this stage is passed, replicated experiments will be necessary to test the significance between what, by then, may be considered to be proved methods of establishment of cocoa.

Many of the results in the tests mentioned below, therefore, are figures or observations on single plots only. Wherever possible, however, figures have been analysed by normal statistical methods. There is, however, great variation between plants, caused largely by shortage of planting material which necessitated the using of all seed and basketted plants. Had sufficient planting material been available, discarding of, say, 30 to 50 per cent. would have been possible and the resulting initial stand of seedlings would have been much more even.

In accordance with the recommendations of the Inter-American Cacao Center of the Inter-American Institute of Agricultural Sciences on standardising the secondary tools of research (3), the metric system has been used in all cocoa measurement. (25 cms. = 10 ins. approx.)

The Tests.

The methods of establishment originally recommended and which, in this article, will be called the orthodox methods, have been described in the cocoa leaflet published in 1949, (2). These methods and their modifications and alternatives are discussed below, under the three headings, Propagation, Establishment in the Field, and Inter-planting with Other Crops.

Propagation.

The orthodox method was to sow the seed in sandbeds and to plant the germinated seedlings in baskets containing a good potting mixture. This method has been very satisfactory but it is rather expensive. Other methods have been tried in an attempt to decrease the cost.

Sowing Seed at Stake.

Seed sown directly in the field, two to a point, at the Federal Experiment Station, Port Swettenham, in October, 1949, germinated well. Subsequent growth was satisfactory but later some plants were killed by too early removal of shade. Seed so planted on North Hummock Estate, Selangor, under mature rubber, suffered severely from damage by ants and rats, but some became established, although growth was poor possibly owing to competition from the roots of the rubber. An experiment at the Federal Experiment Station, Serdang, gave a fairly satisfactory stand but later growth was poor. A trial on Muar River Estate, Johore, gave good establishment but later growth was not satisfactory, probably on account

of inadequate shade. Further tests are to be made at, for example, the Federal Experiment Station, Serdang, and Midlands Estate, Selangor, in areas under jungle.

In general, it may be said that the sowing of seed at stake shows promise provided, (a), adequate seed is available so that several may be sown at each point, (b), weather conditions are satisfactory immediately after sowing, or watering is practicable, and (c), pests, mainly squirrels and ants, and possibly monkeys and porcupine, can be controlled.

Sowing Seed at Stake (or Planting Germinated Seedlings) in Beds for Later Removal to the Fields.

The sowing of seeds 12 to 18 ins. apart in well-drained beds on heavy soil is a common practice in Java. This was tried at Prang Besar and Semenyih Estates in Selangor, and the treatment is included in an experiment now being conducted at the Federal Experiment Station, Serdang. At Prang Besar Estate it was found that the careful extraction of the seedlings with a ball of earth from the bed and their careful transport to the planting site was expensive. At the Federal Experiment Station, Serdang, some plants had all the soil removed from their roots, they were left overnight with their roots in a bucket of water and planted out by Chinese labour, skilled in nursery work, the next morning; surprisingly few (15 per cent.) of the plants died. To sum up, therefore, the method is cheap in that it saves the price of baskets, but, if very careful handling is essential, transplanting is likely to be expensive. If the cocoa plant can be treated more roughly it may become a possible method and therefore, further trials should be conducted.

Cuttings.

Keeping (5) has described how fan and chupon cuttings have been rooted at the Federal Experiment Station, Serdang. More recently, trials have been made using overhead sprays to provide both the high humidity and shade which cocoa cuttings require. It is probable that by adopting these methods the quantity of planting material may be increased. It would appear that in Malaya with its customary high temperature and high humidity, the rooting of cuttings presents fewer difficulties than it does in many other countries. At Muar River Estate, Johore, for example, cuttings obtained from routine pruning of seedlings established in the field have been placed in a sand-bed and are watered twice a day (Plate III); some 60 per cent. produced satisfactory root systems and were established in the field. It is suggested that while the present shortage of planting material lasts, and later where trees of high production and high quality are available, the rooting of all superfluous growth should be performed.

Buddings.

Keeping (5) has described methods used at the Federal Experiment Station, Serdang. It has been shown that, even when rather unsatisfactory budwood, obtained from old parent trees, is used, a fairly high percentage of

successes is obtained. When good budwood, derived from budwood nurseries, is available, budding should present as few difficulties with cocoa as it does with rubber. More recent work at the Federal Experiment Station, Serdang, has shown that with young stocks the most satisfactory method of forcing the bud to shoot is to bend the stock down and peg it (Plate IV). With older stocks, ring barking 6 to 12 ins. above the bud appears to be preferable.

ESTABLISHMENT IN THE FIELD.

It must be again emphasised that this section of the article is to be regarded as an interim report. All that can be recorded are general observations on growth and measurements of height and girth; but it is unlikely that the treatment which causes the maximum growth of cocoa will be the one that becomes common field practice. To take an analogy from rubber, few will deny that, on good jungle soil, rubber makes the best growth when growing by itself, when all other vegetation is removed; yet clean-weeding, desirable though it may be for the immediate growth of the rubber, is not common practice for economic reasons and on account of soil erosion. Again, from another aspect, most planters would prefer to see their rubber ring-weeded rather than strip-weeded so that as much soil is kept covered as possible; yet, owing to ease of supervision, strip-weeding is the common practice. In these trials the object has been to make the cocoa grow and to maintain a high standard of general agricultural practice. The knowledge gained now will doubtless be modified for each individual concern, be it estate or small-holding, according to the type of soil, its situation and the vegetation covering it, the availability of labour and capital, and many other factors.

Some 47 trials, which embodied the various species of primary, secondary and tertiary shades in the orthodox method of planting to which reference was made by Hartley (4), were laid down on Agricultural Stations and estates. Measurements have been recorded on many of these and some of the more interesting ones are given below. Interest in some of these trials was not sustained, due largely to the frequent transfers of estate managers which is a feature of planting in Malaya at present, and the cocoa never really had a chance. Many of the trials showed clearly that maintenance with cocoa must be regularly attended to; to let cover and weeds run riot and then to clear them up suddenly is to ask for trouble, as cocoa will not stand sudden changes in its environment. If drastic measures are necessary, they should be carried out little by little and, if possible, during wet weather.

Normal Methods of Establishment on Cleared Land.

(1) *Federal Experiment Station, Serdang, Selangor. (Expt.F.E.S.S. 38).*

This trial was designed to compare the effect of sowing orthodox primary shade 5 months before the cocoa was planted with sowing it 2 months before, and, at the same time, to test cocoa seedlings grown for 9 months in baskets against those grown for only 4 months in baskets. The trial was planted in a secluded valley, surrounded by jungle, on hill quartzite

soil. *Tephrosia vogelii*, *T. candida*, *Cassia mimosoides* and *Cajanus indicus* were used as primary covers, bananas and *Gliricidia maculata* as secondary shade and various types of tertiary shade were planted but their effect on the cocoa cannot yet be compared. The trial was unreplicated, consisting originally of 16 blocks. After a short time, it was considered that the primary covers were competing too severely with the cocoa and so, 6 weeks after the cocoa was planted, the primary covers were removed slowly, over a period of 3 weeks, and replaced by a shade of palm leaves on half of each block. The number of cocoa plants in each half block varied from 6 to 30 and averaged 15.1. The planting of the cocoa took place in April,1949.

The growth rates for the cocoa are shown in Graphs 1 and 2. These show clearly that the removal of the primary shade and its replacement by palm fronds caused, in all cases, an immediate increase in growth, which was maintained in spite of the secondary covers being kept well under control. It is surprising to find that the variation between the plots from which the covers had been removed and replaced by palm fronds was almost as great as, or greater than, the variation between the plots on which the different species of covers were retained, and that this variation persisted for at least 10 months after the removal of the cover, during which time the plots had received similar treatment. It is also remarkable that although the bush covers were removed only 6 weeks after the cocoa was planted, yet, 10 months later, the plots on which they had been grown for only 4 months were still showing better growth than those on which they had been growing for 7 months. This may be ascribed to the initial set-back the cocoa received, possibly from root competition, soon after it was planted, from which 10 months later it had still not completely recovered, and demonstrates the importance of keeping cocoa growing at a regular rate in its first few years.

Of the four bush covers tested, *Cajanus indicus* almost invariably caused retardation in growth; there was little to choose between the others, *Tephrosia candida* and *Cassia mimosoides* possibly being slightly better than *Tephrosia vogelii*. On the whole, the cocoa which was kept in baskets for 9 months has grown slightly more quickly than that kept for only 4 months in baskets, but it is difficult to draw any useful conclusion from this. In practice, it will probably be uneconomic to use well constructed baskets capable of lasting for more than 6 months, and in any case the length of time the plants are kept in baskets is likely to be decided by the date of seed supply and anticipated weather conditions. The original recommendation that the plants should be kept for some 6 months in baskets is probably sound.

(2) *Federal Experiment Station, Gajah Mati, Kedah. (Expt. SAOK/P 19).*

This experiment consists of two blocks of the standard planting distance experiment (4). In addition to the planting distances, it was designed to test various types of primary shade. The treatments were:—

1. A circle of palm fronds around the cocoa, with the top left open.
2. As above, but with the top closed.

3. *Tephrosia candida* sown in drills 3 ft. from the cocoa.
4. Do. sown in drills 2 ft. from the cocoa.
5. *Cajanus indicus* sown in drills 4 ft. from the cocoa.
6. Do. sown in drills 2 ft. from the cocoa.

The soil is a hill quartzite of low fertility with underlying laterite subsoil. Both the cocoa and the bush covers were sown at the same time, and the cocoa was then kept in baskets for 5 months. Secondary shade was bananas while *Enterolobium saman* and *Parkia speciosa* were planted as tertiary shade. The planting of the cocoa took place in September, 1949.

The growth rates of the cocoa are shown in Graph No. 3. Statistical analysis of the figures shows that palm fronds are significantly better than the *Tephrosia candida* which, in its turn, has done significantly better than *Cajanus indicus*. There are no differences within the three types of primary shade. Differences in height were also reflected in differences in girth at 14 months from sowing, which for treatments 1 to 6 were, respectively, 4.0, 4.3, 3.5, 3.5, 3.0 and 3.0 cms.

(3) *Tangkak Agricultural Station, Johore. (Expt. J.C.T.6.).*

This experiment consists of a single block of the standard planting distance experiment. The primary shade treatments were:—

1. *Tephrosia candida* 3 ft. radius rings.
2. Do. in drills 3 ft. from the cocoa.
3. Do. in drills 2 ft. from the cocoa.
4. *Cajanus indicus* 4 ft. radius rings.
5. Do. in drills 4 ft. from the cocoa.
6. Do. in drills 3 ft. from the cocoa.

One month before the cocoa was planted out the bush covers in Treatments 1 and 4 were removed and replaced by palm fronds, which in Treatment 1 were left open on top, while in Treatment 4 they were closed. The soil is a poor quality Raub series type which varies considerably, as shown by its degrees of stoniness. The cocoa was kept in baskets for 7 months and the covers were planted 5 months before the cocoa was planted in the field, which took place in August-September, 1949. Secondary shade was bananas and tertiary shade *Parkia speciosa*.

The secondary covers were kept well in control and cocoa height measurements, taken in February, 1950, are shown in Table I.

Table I.
Height of Cocoa at Tangkak Agricultural Station (Expt. J.C.T.6.)
(in cms.)

Treatment	Height	Mean
Palm fronds open at the top	40.6	42.1
do. closed at the top	43.7	
Tephrosia candida drills 3 ft. from cocoa	41.7	43.4
Do. do. 2ft. do.	45.2	
Cajanus indicus drills 4 ft. from cocoa	41.7	38.2
Do. do. 2ft. do.	34.8	

It will be seen that growth in general has been poor and, although statistical analysis does not show any significant differences between treatments, it is clear that, at any rate in so far as the worst results have been obtained with *Cajanus indicus*, they fall into line with previous results.

(4) *Gedong Estate, Perak. (Expt. PK.N. 8/49).*

This is one of the standard 5-acre, estate trials described by Hartley (4). Four primary covers, *Tephrosia vogelii*, *T. candida*, *Cajanus indicus* and *Crotalaria anagyroides* were sown slightly before the cocoa was planted in the field. Secondary shade was bananas and *Gliricidia*. The cocoa was transplanted in October, 1949, after being in baskets for 7 months. The soil is a stiff coastal clay which has been well drained.

The growth rates are shown in Graph No. 4. It will be seen that *Crotalaria anaggroides*, which was not tested in the previous trials, has done best. It is interesting to note that the measurements from the banana block are better than those from the *Gliricidia* block. This may be due to a fertility trend or to the bananas removing excess water by transpiration or to their roots opening up the soil, and so encouraging drainage. In view of the evenness of the Malayan coastal clays in general, the last of these possibilities may be the correct answer.

(5) *R.R.I.* Experiment Station Cocoa Trial II. (Expt. SAOR. 3.)*

This experiment consists of five unreplicated blocks. *Crotalaria anagyroides* was sown in drills 3 ft. away from the cocoa rows 2 months before the cocoa was planted but, owing to dry weather, it did not really become established until the wet season, when the cocoa was transplanted; in addition all blocks were given artificial shade of palm fronds. The treatments were as follows:—

1. Cocoa planted 12 x 12 ft. with bananas as secondary shade and *Parkia* as tertiary shade.
2. Cocoa planted 12 x 12 ft., no secondary or tertiary shade.
3. Cocoa planted 8 x 8 ft. with bananas as secondary shade and *Parkia* as tertiary shade.
4. As above but with no teritary shade.
5. As above, no secondary shade but a few *belukar**, bushes left for tertiary shade.

The soil is a sandy quartzite and the cocoa was transplanted in October, 1949, after being in baskets for 6 months.

The growth-rates are shown in Graph No. 5. The very satisfactory growth-rate will be noticed; it is considered that this was caused to a large extent by the fact that the *Crotalaria* was kept well in control and there was little damage by insects. It will be observed that Blocks 2 and 5, the ones which contained no bananas, have made the best growth. The average girths at 13 months from sowing for the five treatments were, 4.4, 4.4, 4.4, 4.7 and 5.0 cms. respectively.

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*Rubber Research Institute of Malaya.

*Secondary jungle growth.

(6) *Kuala Ketil Estate, Kedah. (Expt. SAO. K/P. 41.)*

This trial consists of three 1½ acres blocks, planted with cocoa and Manila hemp, the planting distance of both being 12 x 12, 18 x 18 and 24 x 24 ft. All cocoa plants were provided with artificial shade of palm fronds but no primary covers were planted, the natural undergrowth, which was mainly grass and low herbs, being allowed to regenerate. The soil is a good valley quartzite. The cocoa was transplanted in May, 1949, after being 6 months in baskets. The Manila hemp was well established before the cocoa was transplanted. (Plate V).

The growth-rates are shown in Graph No. 6. It will be seen that the best growth has been made where spacing of both the cocoa and Manila hemp was at the widest. This confirms, to some extent, the suspicion aroused in trial R.R.I. No. II, that secondary shades such as bananas, or in this case the the Manila hemp, compete to some degree with the cocoa, at any rate on quartzite soils.

(7) *R.R.I. Experiment Station Cocoa Trial III. (Expt. SAOR. 4.)*

It was shown at an early stage that cocoa grown on cleared land benefitted from the construction of an artificial shade of palm fronds around the plant. This trial was designed to ascertain the amount of shade necessary; concurrently certain agricultural methods of controlling night-flying cockchafers, such as *Apogonia*, were incorporated into the experiment. The experiment consisted of three blocks, on all of which a primary shade of *Crotalaria anagyroides* was planted and kept under control by slashing; secondary shade of bananas was also established. The following treatments were then applied:—

A. No artificial shade.
B. Artificial shade for 4 months.
C. Artificial shade for 8 months.

Each of these blocks were then split for seven sub-treatments:—

1. Grass mulch.
2. Grass mulch + Calcium cyanamide at 2 ozs. per plant every other month.
3. Grass mulch + N.P.K. Mixture at 2 ozs. per plant.
4. Grass mulch + a proprietary Gammexane compound at 2 ozs. per plant.
5. Calcium cyanamide at 2 ozs. per plant.
6. N.P.K. Mixture at 2 ozs. per plant.
7. Control.

The growth-rates of the plants receiving primary treatments are shown in Graph No. 7, while the girths at 13 months were 2.8, 2.8, and 3.1 cms. The trial is in a less fertile area than that of R.R.I. No. II (Expt. SAOR. 3.) but it is clearly shown that the provision of artificial shade encourages growth. This is well shown in Plates VI; VII and VIII; the photographs were taken after the cocoa had been in the field for 8 months.

The sub-treatments were applied for the first time in March, when the cocoa had been in the field for 6 months. The height records are shown in Table II.

Table II.

Heights of the Cocoa in the Sub-Treatments of Trial R.R.I. No. III (Expt. SAOR. 4.) after 8 Months.

(in cms.)

Treatment	Calcium cyanamide	N.P.K. mixture	Gammexane compound	Control	Mean
Mulch	107	95	96	83	95
No mulch	90	95	—	79	88
Mean	98	95	—	81	—

Although the height measurements taken in May do not show significant differences, there are indications that the treatments are having some effect.

Alternative methods of establishment on cleared land.

The results of the trials described above show the lines along which investigations into alternative methods of establishment are moving. Artificial shade of palm fronds has been shown to be beneficial and to control night-flying beetles to some extent (Plate IX); if such shade is provided, there seems to be little point in providing herbaceous covers which are generally expensive to establish. Trials are now being carried out with creeping covers such as *Centrosema pubescens* or *Calopogonium mucunoides*, which have the disadvantage that they may climb the artificial shade and the cocoa, or with natural covers kept under control by slashing. Alternatives, such as the growing of maize between the cocoa rows, or the establishment of cocoa in *keladi (Colocasia)* or tapioca *(Manihot)* are also being tested. Although it appears that in Malayan conditions maximum growth may not be achieved if such plants as bananas or Manila hemp are grown as secondary shade, experience with mature cocoa at Cheras Agricultural Station, Selangor, indicates that they will be necessary later. Although no evidence is yet available on the importance of tertiary shades it is likely that they will be beneficial, so trials with various species, or more often with a combination of species, are being continued.

Establishment in jungle.

The normal practice for establishing cocoa in the Gold Coast in West Africa is to plant in jungle, most of the large trees being left; the general environment remains that of jungle, the lower storeys being replaced by cocoa. This is now being tried in several places in Malaya.

(1) *R.R.I. Experiment Station, Cocoa Trial I. (Expt. SAOR 2.).*

A narrow strip of secondary jungle, 40 yards wide, became available at the R.R.I. Experiment Station for this trial. It was divided into six

blocks, each 60 yards long, on which the following treatments were planted:

1. Cocoa planted 12 x 12 ft. jungle trees left at a stand of 70 per acre, remainder poisoned; secondary shade of bananas planted.
2. Cocoa planted 12 x 12 ft. jungle trees progressively thinned, no bananas planted.
3. Cocoa planted 8 x 8 ft., jungle trees left at a stand of 70 per acre, remainder poisoned, no bananas planted.
4. Cocoa planted 8 x 8 ft., jungle trees left at a stand of 70 per acre, remainder poisoned, secondary shade of bananas planted.
5. Cocoa planted 8 x 8 ft. jungle trees progressively thinned, no bananas planted.
6. Cocoa planted 8 x 8 ft., all jungle trees poisoned 3 months after cocoa transplanted, secondary shade of bananas.

The soil is a hill quartzite and the cocoa was transplanted in October, 1949, after being in baskets for 6 months.

The growth-rates of the various treatments are shown in Graph No. 8, and the girths at 13 months from sowing were 3.8, 4.1, 5.3, 5.0, 4.1 and 4.4 cms. respectively. It will be seen that the growth of the plants is good, although not quite so quick as that of the plants grown in the open alongside in R.R.I. Cocoa Trial II recorded in Graph No. 5; girth measurements, however, were as good or better. It will be noticed that in comparative treatments (1 and 2 against 4 and 5) cocoa spaced at 8 x 8 ft. is better than at 12 x 12 ft.; at this stage the planting distance can clearly have no real effect on the growth of the cocoa and no reliance, therefore, must be placed on differences between treatments. Attention must, however, be called to the rapid growth made by treatment No. 6 between the 10th and 13th month, following the poisoning of all trees; this rapid growth is outstanding and the plot can be picked out by its good appearance in the field. Plate X gives some idea of the density of shade in these plots; the cocoa in them survived the dry weather in May and June far better than that on the plots in Trial No. II, which became very yellow in appearance.

(2) *Sungei Senarut Estate, Johore. (Expt. J.C.T. 7.).*

In this trial, a single block of 4.3 acres, all the large jungle trees were felled and piled between the cocoa rows; a stand of about 160 medium sized trees to the acre was left but was later reduced to 120 per acre. This resulted in a patchy canopy, shade being denser in some areas than in others. Some broken lines of *Cajanus indicus* were, therefore, planted in the cocoa rows and where the shade was considered inadequate. The cocoa was transplanted at 9 months old, in July, 1949. The soil is of the Raub series and contains many lateritic nodules. The average height of the cocoa after six months in the field was 83.1 cms., and at twelve months many were over 180 cms. in height. Plate XI shows this method of planting.

Further trials of this type are being conducted but enough knowledge has been gained to make it certain that cocoa can be established under jungle shade and that in this way costs are likely to be far less than when it is established from cleared land.

INTERPLANTING WITH OTHER CROPS.

This problem, which has been discussed in a previous article by Hartley (4), falls into two categories:—

(a) the planting of cocoa in other crops which are already mature and in bearing,

(b) the planting of cocoa at the same time as, or soon after, the planting of the other crops.

(a) *The Interplanting of Cocoa in Mature Crops.*

RUBBER.

Attempts have been made to grow cocoa under mature rubber on several estates. It was considered in several quarters, from the evidence of successful trials in Ceylon, that little difficulty would be found; however, no stand which really shows promise has yet been seen in Malaya. It would appear that in Ceylon most of the rubber areas in which cocoa is growing well are at a considerably higher altitude than that at which rubber is normally grown in Malaya, that most of the rubber trees are very old and yielding very little and that the stand per acre is low.

Braemar Estate, Selangor. (S.A.O. Sel. 6/50.).

Two attempts were made to establish cocoa under old rubber trees, some of which were very large, on granite soil. In neither attempt did the cocoa make any appreciable growth in spite of manuring. When the plants were dug up for inspection it was found that the rubber roots had entered the planting baskets.

North Hummock Estate, Selangor. (S.A.O.Sel. 7/50.).

Attempts were made to establish cocoa on quartzite soil by sowing seed at stake and by planting seedlings in baskets. Although some plants became established, growth was slow and the leaves were very yellow in colour.

Belata River Estate, Selangor. (S.A.O.Sel. 9/50.).

A trial was planted under the light shade of clonal rubber B.D.5 and the heavy shade of Rubana 393. The cocoa was transplanted in April, 1950, when 6 months old; good establishment has been achieved but it is too early to say whether the cocoa will grow successfully.

Sungei Bagan Estate, Kelantan. (S.A.O. Kel. 40.).

Here, a small patch of cocoa has been established at the side of a field of rubber where it is exposed to the light. Trenches have been opened around the cocoa at regular intervals of time and the cocoa is growing satisfactorily. It is unlikely, however, that this could be done economically on a large scale.

COCONUTS.

Changkat Estate, Province Wellesley. (AOP&PW. Chg. No. 1.).

30 cocoa seedlings were planted on coastal clay in an area of dwarf coconuts which were planted 20 x 20 ft. square in about 1935 and have

since made normal growth. ' The cocoa was raised in baskets and transplanted when two months old, also at 20 x 20 ft. in February, 1948. The average height after 15 months in the field was 110.1 cms. Growth, although slow, has been fairly good, and well shaped plants have been produced. Plate XII shows part of the field.

Oil Palms.

No trials have as yet been made with cocoa interplanted in mature oil palms.

(b) *The Interplanting of Cocoa with Immature Crops.*

In order to encourage diversification of cropping, experiments have been designed to test the possibilities of interplanting not only cocoa but also several other, at present, secondary crops with major crops. Details of these experiments have been sent to Agency Houses and estates, and arrangements are being made to conduct a series of experiments throughout Malaya, but details have not yet been completed. Several simpler trials, however, have been laid down during the past two years and these are described below.

Rubber.

Federal Experiment Station, Port Swettenham. (Expt. S.A.O. Sel. 3 & 4/49.).

Two small blocks have been planted to test whether cocoa can be established in hedge-planted rubber, both with and without isolation ditches. The cocoa was transplanted in October, 1949, and growth has been vigorous. No observable differences can yet be expected.

Batang Malaka Estate, Negri Sembilan. (Expt. S.A.O. N.S. 6.).

Two small blocks of cocoa, each of 26 plants, were planted with 9 months old seedlings in February, 1950. Both blocks were in rubber planted in 1947, one planted 22 x 11 ft. and the other 16 x 16 ft. The growth of the cocoa at present is good.

Pertang Estate, Negri Sembilan. (Expt. S.A.O N.S. 5.).

Here a single row of cocoa, with plants 12 ft. apart in the row, has been interplanted between young hedge-planted rubber, with hedges 50 ft., apart. The trial is on virgin calcareous soil; all high trees have been felled and forest growths are being allowed to regenerate between the rows. The cocoa was planted in February, 1950, after 14 months in baskets, and, in May, 1950, the average height was 74.6 cms.

R.R.I. Experiment Station. (Expts. SAOR 2, 3, 4 and 5.).

The experiments at the R.R.I. Experiment Station, described in the previous section, were interplanted between rubber planted in double rows, triangularly, in hedges 60 ft. apart. The cocoa was transplanted in October, 1949, and so far both the cocoa and the rubber are growing well. (Plate XIII).

Muar River Estate, Johore. (Expt. J.C.T. 1, 2 and 3.).

Three trials were laid down on this estate on partly volcanic soil to test the effect on the cocoa of rubber planted in hedges and in clumps, compared with no rubber. The cocoa was planted in November, 1948, after being 6 months in baskets but both the cocoa and primary covers have been severely attacked by pests and no conclusions can yet be drawn. After being 13 months in the field, the average heights for the three trials were 126.5, 116.1 and 128.3 cms.

Coconuts.

Strathmashie Estate, Bagan Datoh, Perak. (Expt. PK.S. 15/49.).

This trial consists of six blocks, in which different combinations of cocoa and coconuts are being tested. The soil is a heavy coastal clay. The cocoa was planted in October, 1949, and growth on the whole has been good. Rhinoceros beetles *(Oryctes)* were attracted by the cattle manure placed in the planting holes, and several cocoa seedlings were killed either by their larvae or those of other cockchafers.

Oil Palms.

Sungei Samak Estate, Perak. (Expt. PK.S. 16/49.).

This is a similar trial to that on Strathmashire Estate, but with oil palms in place of coconuts. The cocoa was planted in January and February, 1950, and in May the seedlings had reached a height of 90 cms.

Conclusions.

Propagation.

The recommended methods of planting germinated seed in baskets are satisfactory but rather expensive. Germinated seed, planted at stake, is worth trying on a large scale as soon as supplies of planting material are adequate. There is little difficulty in rooting cuttings and it is suggested that attempts should be made to root all pruned shoots in order to obtain additional planting material. When budwood of high-yielding clones is available, bushes from such rooted cuttings may be budded.

Establishment.

The recommended method of establishing cocoa on cleared land by means of a series of primary herbaceous shades, and secondary and tertiary shades, has been shown to be very expensive. The main difficulty in establishing cocoa by this method lies in the severe damage often caused by night-flying cockchafers (*Apogonia* and other spp.). Of the various species of bush covers tested, *Tephrosia candida* and *Cassia mimosoides* did better than *Tephrosia vogelii* and *Cajanus indicus* on most soils, but *Cajanus* can be satisfactory on caly soils. The *Crotalaria spp.* provided they are not attacked by rust, are satisfactory. It has been found, however, that the removal of these primary covers and their replacement by an artificial shade of palm fronds almost invariably leads to an increase in growth, and, furthermore, the artificial shade appears to act as a physical barrier to night-flying beetles.

It is too early to expect results from secondary shade but, as with primary covers, it is possible that they may cause root competition. *Gliricidia* will probably be best on inland soils and bananas on coastal clays.

Tertiary shade will probably be required. If jungle trees or saplings are already growing on the area they should be left. If there are no trees or tree seedlings, then several different species of tertiary shade should be planted in preferenc to a single species so that, if a pest or disease should attack one species, the others would still remain.

It is clear that cocoa thrives in jungle or semi-jungle conditions. The establishment of a good stand of cocoa is more easily and cheaply attained from jungle than from *belukar* or old rubber land.

Interplanting with other crops.

It is unlikely that it will be possible to establish cocoa under mature rubber. With coconuts and oil palms it may be easier, and possibly be an economic proposition. Trials have been started on the interplanting of cocoa in young stands of rubber, coconuts and oil palms. Growth appears to be satisfactory but no conclusions of practical value can be drawn until the crops are in bearing.

Acknowledgements.

These investigations are a continuation of the work started by Mr. C. W. S. Hartley, Senior Agricultural Officer (Research). Acknowledgement is made to the help and advice given by Mr. O. J. Voelcker, C.B.E., Director of Agriculture, and to other members of the Department who have been responsible for the laying down and conduct of these experiments, and to the Director of the Rubber Research Institute of Malaya and his staff for conducting the cocoa trials at their Experiment Station. Also all thanks are due to the Managers of the estates concerned, without whose assistance and co-operation these trials would have been impossible.

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3. *Cocoa Information Bulletin.* Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica. Vol. 1, No. 24 October, 1949.
4. Hartley, C.W.S. Investigations into the Growing of Cocoa in Malaya. *Malayan Agricultural Journal*, Vol. XXXII, April, 1949.
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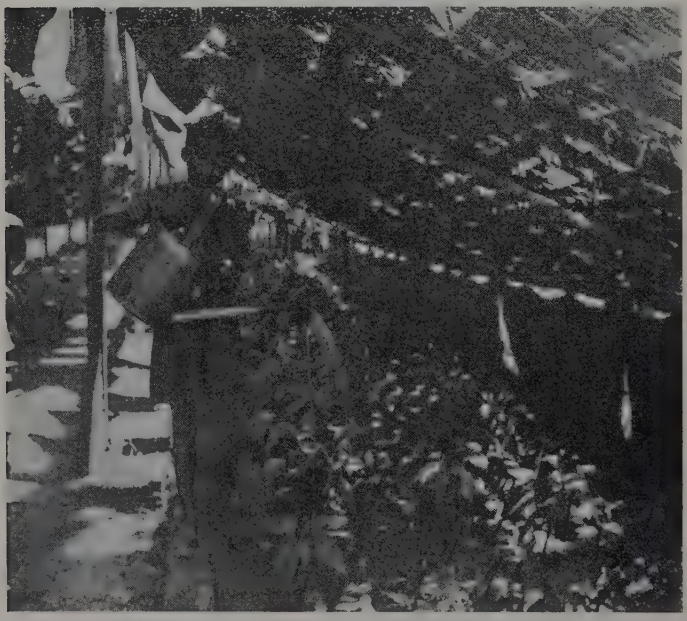
PLATE I.

Cocoa bush showing two jorquettes.

PLATE II.

Typical unshaded tree with many chupons, Serdang.

PLATE III.



Rooting of chupon cuttings, Muar River Estate.

PLATE IV.

Cocoa seedlings bent over after budding, Serdang.

PLATE V.

8 months old cocoa plants, unshaded. Rubber Research Institute.

PLATE VI.

8 months old cccoa plants, shaded for first 4 months,
R.R.I. Experiment Station.

PLATE VII.

8 months old cocoa plants, shaded
R.R.I. Experiment Station,

PLATE VIII.

Cocoa in jungle. R.R.I.

PLATE IX.

Cocoa in jungle Sungei Senarut Estate.

PLATE X.

Cocoa in mature dwarf coconuts, Changkat Estate.

PLATE XI.

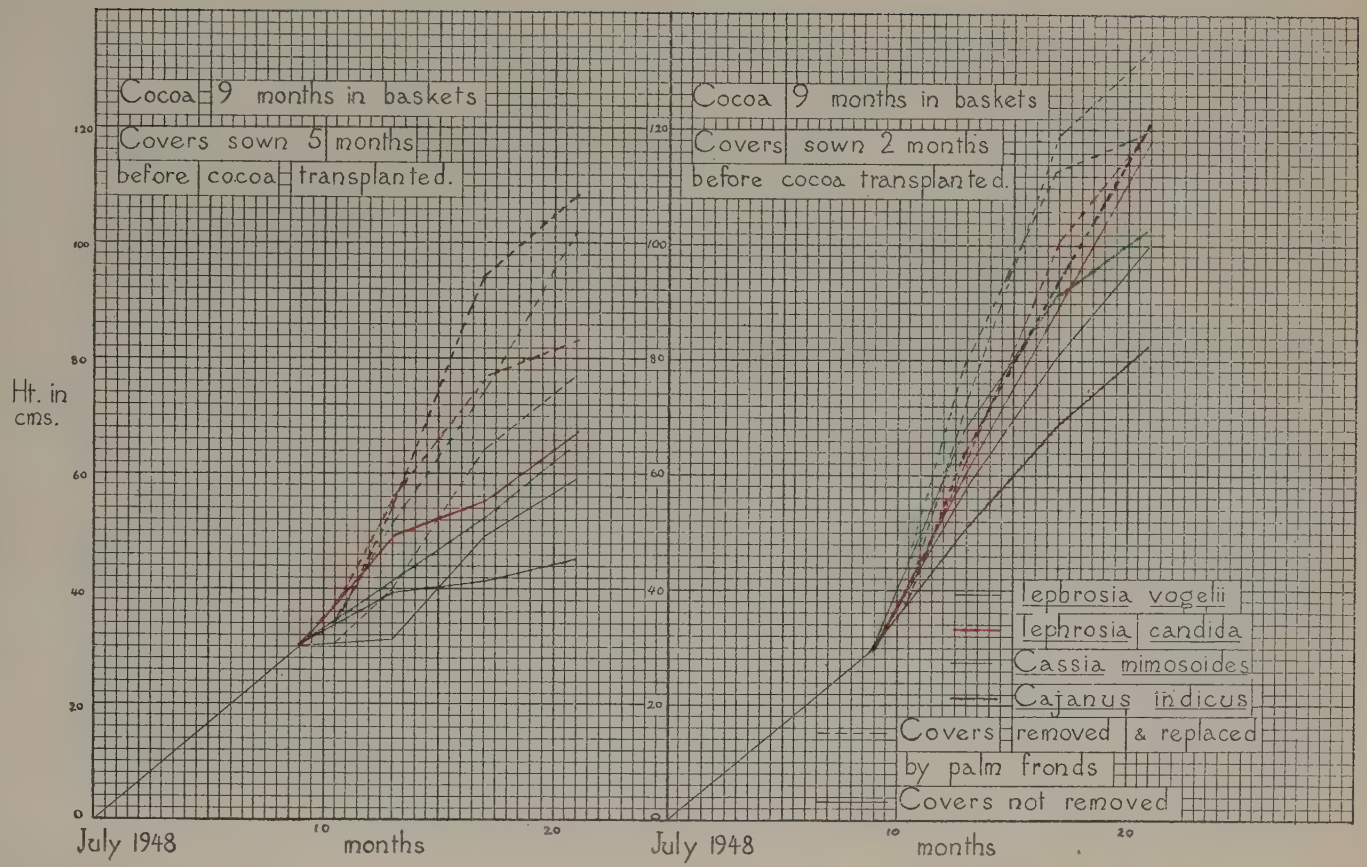
Cccoa with rubber under jungle. R.R.I.

PLATE XII.

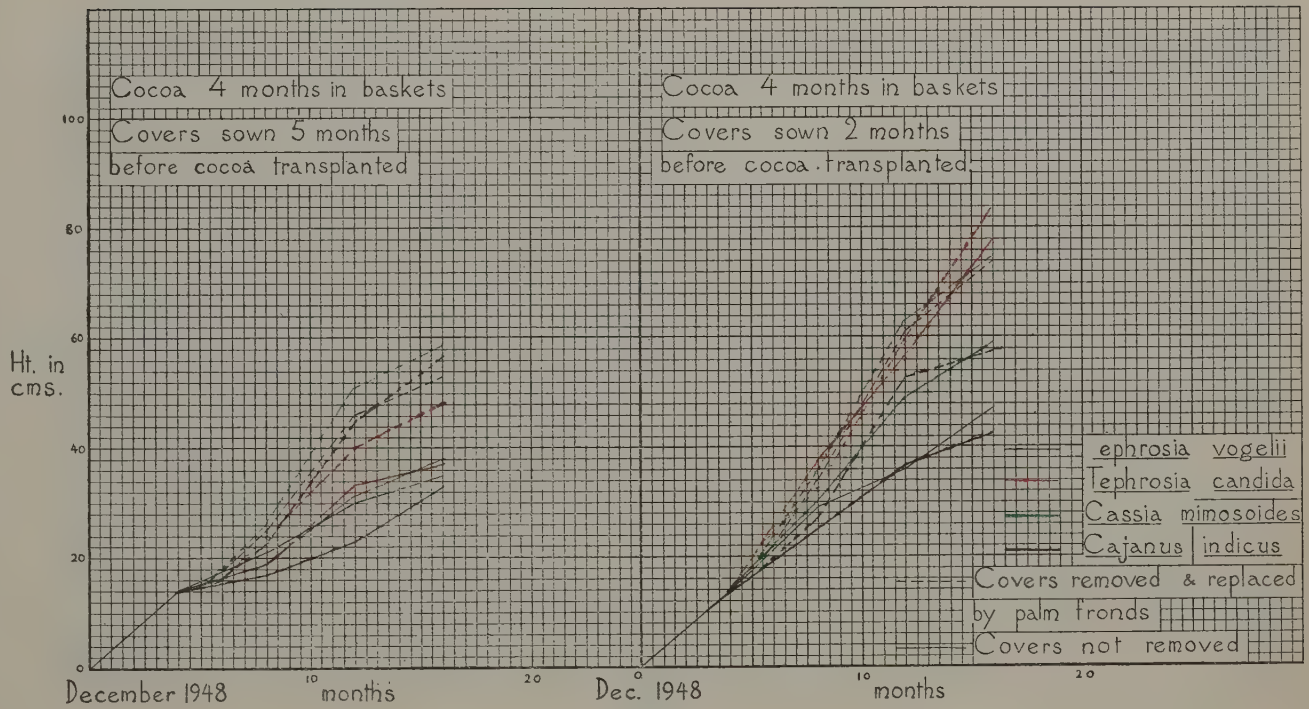
Recently planted cccoa at Federal Expernment Station, Serdang.

PLATE XIII.

Cocoa and Manila Hemp Kuala Ketil Estate.

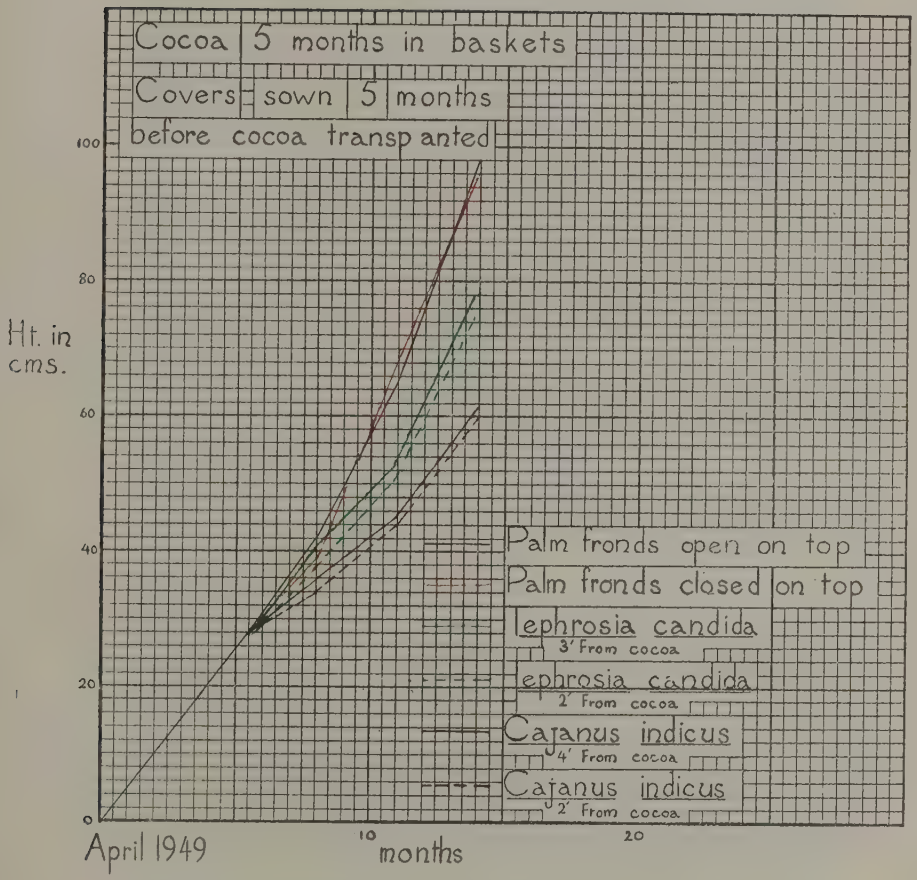


GRAPH I.
Growth Rates of Cocoa in Expt. F.E.S.S. 38.



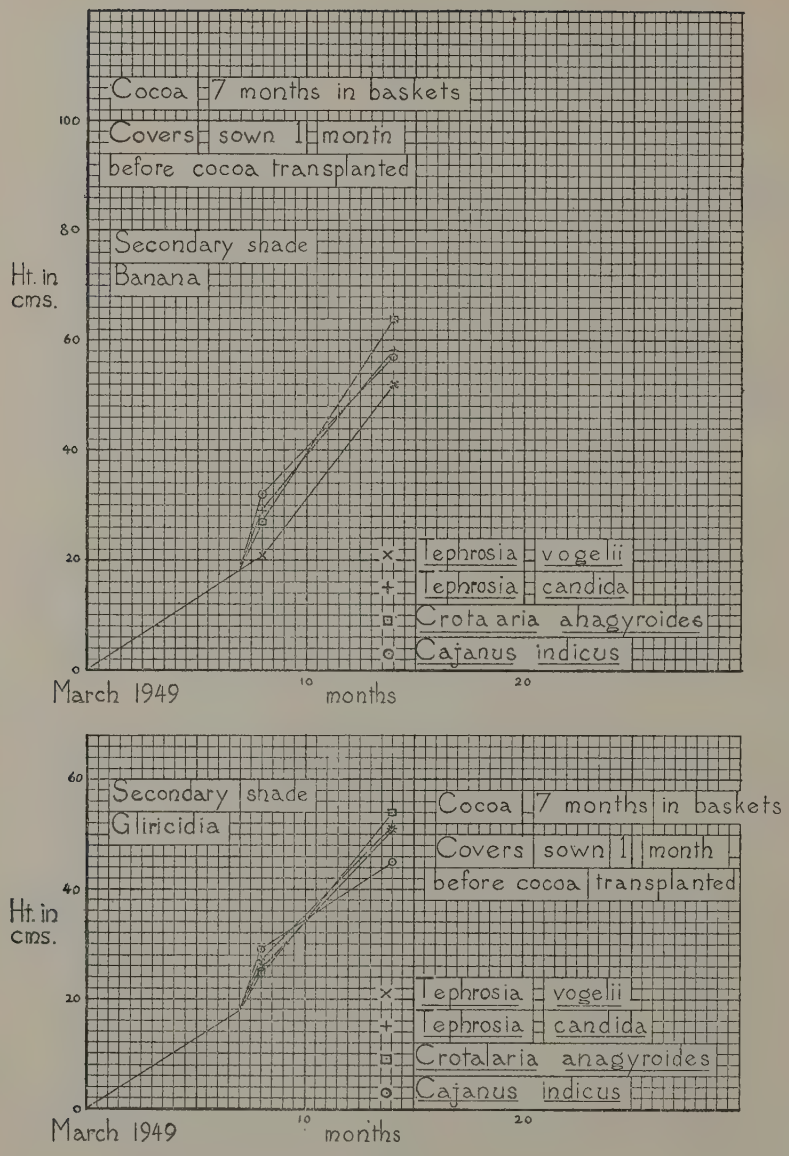
GRAPH 2.

GROWTH RATES OF COCOA IN EXPT. F.E.S.S. 38.



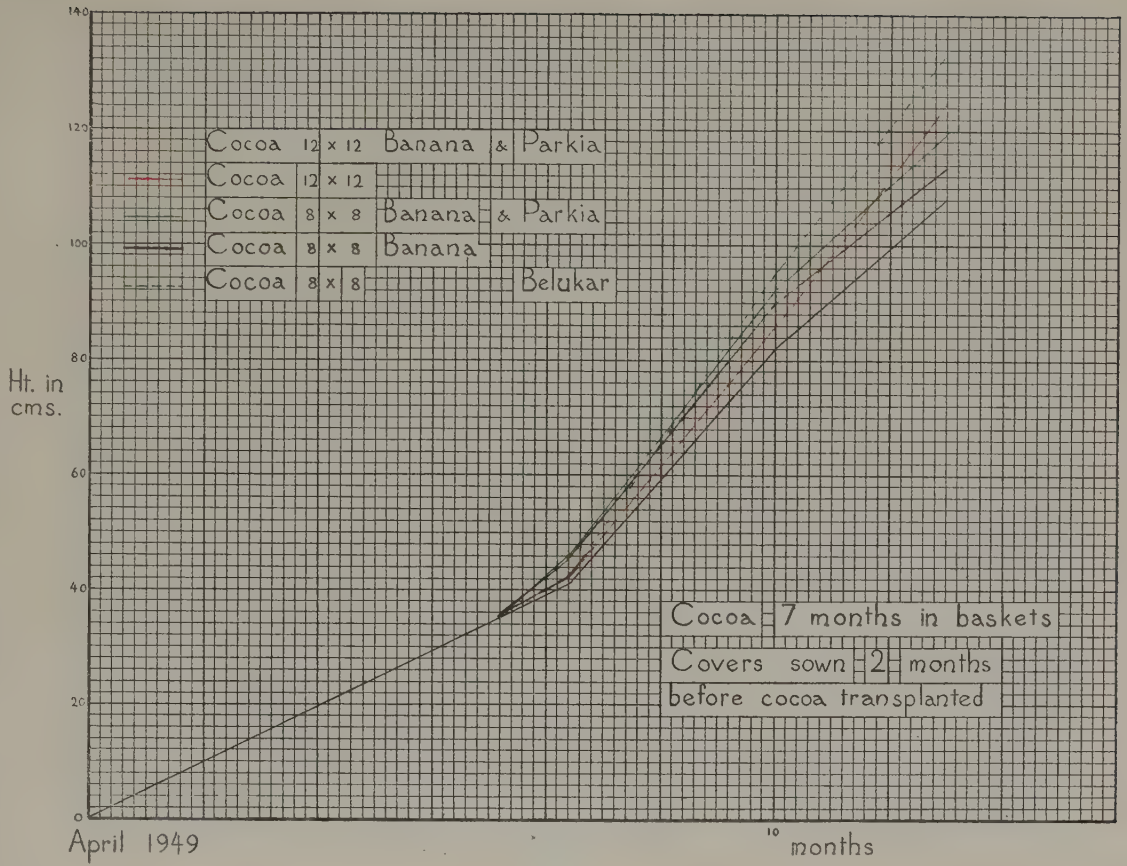
GRAPH 3.

GROWTH RATES OF COCOA IN EXPT. S.A.O. K/P. 19.

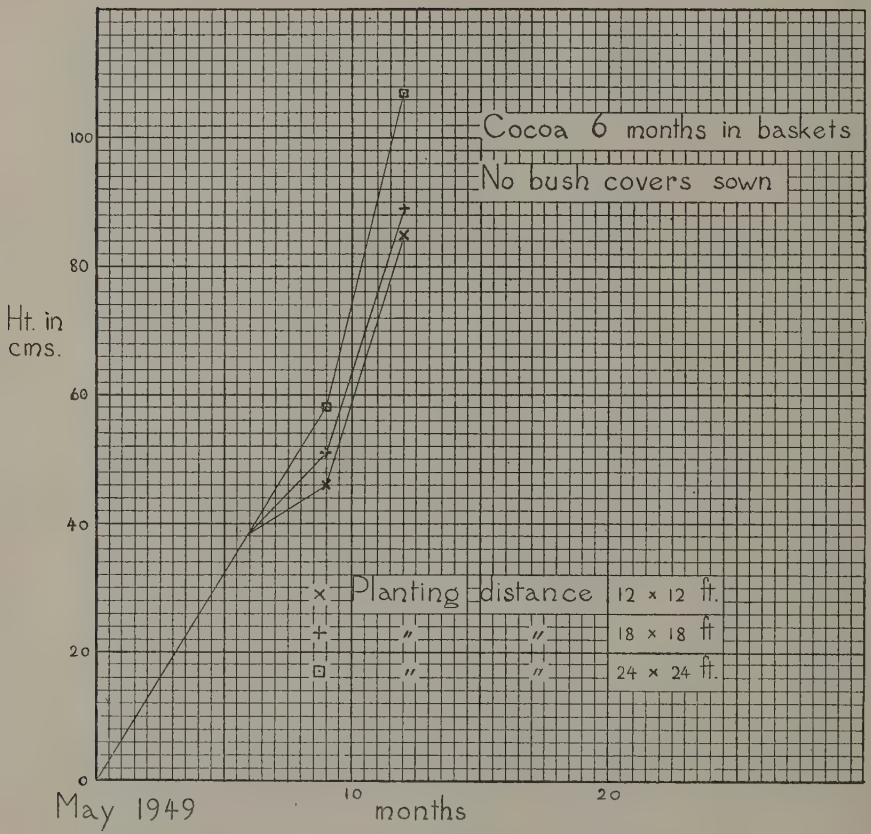


GRAPH 4.

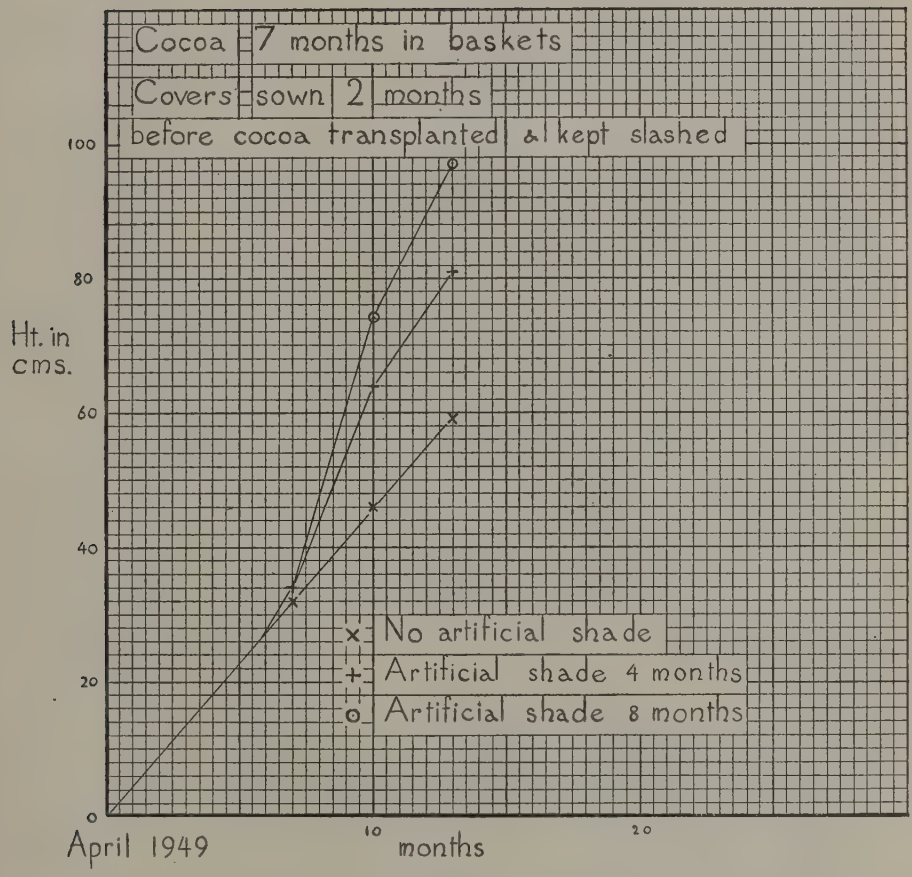
GROWTH RATES OF COCOA IN EXPT. P.K.N. 8/49.



GRAPH 5.
GROWTH RATES OF COCOA IN EXPT. S.A.O.R. 3.

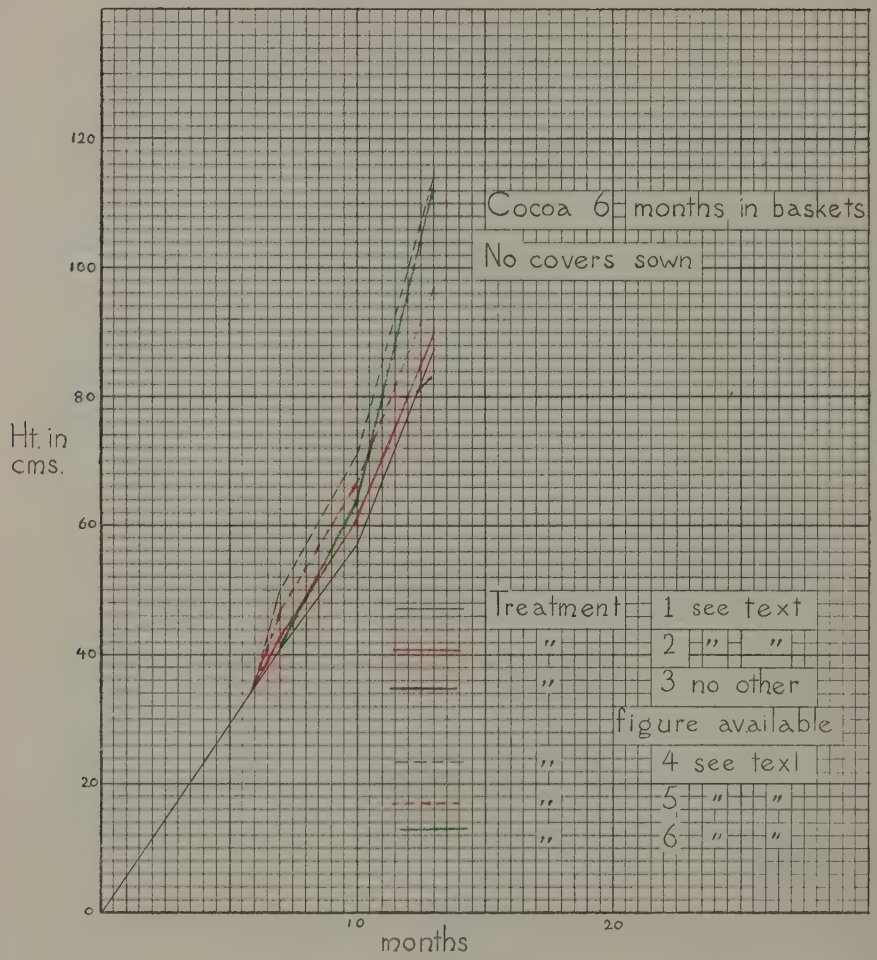


GRAPH 6.
GROWTH RATES OF COCOA IN EXPT. S.A.O. K/P. 41.



GRAPH 7.

GROWTH RATES OF COCOA IN EXPT. S.A.O.R. 4.



GRAPH 8.

GROWTH RATES OF COCOA IN EXPT. S.A.O.R. 2.

THE INTRODUCTION OF AMELONADO COCOA FROM THE GOLD COAST TO MALAYA.

BY

ALDWORTH THOMPSON,

Senior Plant Pathologist.

Introduction.

At the request of the Government of the Federation of Malaya, the Colonial Office arranged for an expert in cocoa growing, Professor E. E. Cheesman, formerly on the Staff of the Imperial College of Tropical Agriculture, Trinidad, to examine the potentialities of Malaya, Sarawak and North Borneo for commercial cocoa production. Professor Cheesman visited these territories during the period December, 1947, to March, 1948, and reported that prospects were sufficiently good to justify expenditure on serious attempts to establish cocoa on a commercial scale. Among the recommendations made in his report (1) he advised the consideration of a co-ordinated scheme for the introduction and bulking of planting material of cocoa, the scheme to be worked by the Department of Agriculture, Federation of Malaya, and stressed that introductions from other regions, such as West Africa and the West Indies, should only be made under careful supervision and quarantine. The presence in those regions of diseases and pests not known in Malaya made it obligatory to avoid the introduction of these enemies of cocoa along with any planting material imported from the Western Hemisphere or from Africa.

A grant of money for the purpose of collecting and introducing cocoa planting material was made available by a scheme sponsored under the Colonial Development and Welfare Act (U.K.), and plans were made to provide an isolation nursery where such material would be received and grown.

After examination of the facilities offered on various islands off the coast of Malaya, a site was chosen on Pulau Tekong Besar near Changi, Singapore. (Plate 1, Fig. 1.). The site is distant from areas where cocoa is likely to be grown, is accessible from Singapore—the main port of entry of planting material arriving by air or sea—and yet is comparatively isolated. Shelters etc., for the accommodation of imported material, were erected in time to receive the first consignment, i.e., seeds of the Amelonado variety from the Gold Coast, which arrived at the end of November, 1949.

Arrangements for the Introduction of the Cocoa.

It was arranged that the writer, who was on leave in England in 1949, should return to Malaya via the Gold Coast, study the diseases and pests of cocoa at the West African Cacao Research Institute, Tafo,

bring approximately 5,000 seeds of Amelonado cocoa by air to Singapore, and supervise their growth at the isolation nursery until satisfied that the plants so obtained were free from disease.

It is known that cocoa pod-tissue in West Africa may carry the "swollen shoot" virus and that the pods can be hosts of the eggs of the sucking bugs *Salbergella singularis* and *Distantiella theobroma*. These bugs and the cocoa virus are not known in Malaya but are destructive to cocoa in West Africa. Consequently, it was decided that seed in pod would not be taken to Singapore. In view of the risk that spores of the "mealy pod" fungus *(Trachysphaeria fructigena)*, or other undesirable fungi not recorded in Malaya, might lodge on the mucilaginous coating of the seeds, or be present in the packing material, it was arranged that the seeds would be extracted from the pods at Kano, Nigeria, and packed in charcoal powder obtained at Kano.

Method of Packing.

Information as to a suitable method of packing and transporting cocoa seed was obtained from the Imperial College of Tropical Agriculture, Trinidad. Briefly, the method advised was as follows:—the seeds should be placed ½ in. apart, in layers, in fairly finely ground, unsterilised charcoal powder of an initial moisture content of between 35 and 40 per cent. (obtained by mixing one part of charcoal saturated with water with nine parts of air-dry charcoal powder). Tins (10 x 10 x 10 ins.) could be used as containers and these should have six ventilation holes, each 2 mms. in diameter, spaced equally from each other, and made in each side, top and bottom. If the charcoal should be too moist, excessive development of the hypocotyl might occur and this is liable to be injured in the confined space. The seeds must not be exposed for any length of time to temperatures below 55°F. and lagging of the containers with cork shavings or wood "straw" would be necessary if the seeds were sent by air and were likely to be exposed to chilling temperatures.

Transport Arrangements.

When booking the air passages with the London office of the British Overseas Airways Corporation for the return journey, from Accra in the Gold Coast *via* Kano in Nigeria, Castel Benito near Tripoli, North Africa, Cairo, Karachi and Calcutta to Singapore, the matter of whether the seed, carried as freight, in the York and Constellation aircraft to be used *en route*, would be exposed to low temperatures was discussed. Information received from the Meteorological Office of the Air Ministry (see Tables I and II) indicated that chilling could occur, particularly between Tripoli and Singapore, if the freight compartments were not pressurised. Such compartments are available in both these types of aircraft, but permission was obtained for the accommodation of the seeds in the passenger compartment if, for any reason, it should be necessary.

Table I.

Ground Temperature in November.

Place	Mean daily max.	Mean daily min.	Mean monthly min.
	°F.	°F.	°F.
Accra ..	87	75	71
Kano ..	94	61	55
Tripoli ..	76	53	44
Cairo ..	78	58	50
Karachi ..	85	67	57
Calcutta ..	82	65	58
Singapore ..	85	75	72

Table II.

Estimated Values of Temperature (°F.) Likely to be Exceeded on 99, 50 and 1 per cent. of Occasions in November in free Air.

Place	Height above sea level.								
	5,000 ft.			10,000 ft.			15,000 ft.		
	99 per cent.	50 per cent.	1 per cent.	99 per cent.	50 per cent.	1 per cent.	99 per cent.	50 per cent.	1 per cent.
Accra ..	54	64	74	44	52	60	26	34	42
Kano ..	54	64	74	44	52	60	26	34	42
Tripoli ..	34	52	70	23	39	55	5	23	41
Karachi ..	43	61	79	30	46	62	12	30	48
Cairo ..	36	54	72	25	41	57	9	27	45
Calcutta ..	41	59	77	29	45	61	12	30	48
Singapore ..	54	64	74	42	50	58	28	36	44

Note: the 50 per cent. value gives the mean temperature, and the 99 per cent. and 1 per cent. values are estimates of the extremes.

Itinerary.

The following itinereary was arranged:—

London to Accra 12th November, 1949, by York aircraft.
Arrive Accra 13th November, 1949.
Accra to Kano on 20th November, 1949, by York aircraft.
Kano to Tripoli on 21st November, 1949, by York aircraft.
Tripoli to Cairo on 22nd November, 1949, by York aircraft.
Cairo to Singapore on 23rd and 24th November, 1949, by Constellation aircraft.

Containers.

Tins of the size mentioned above were not readily available but 48 sandwich tins ($7\frac{1}{2}$ x $5\frac{1}{2}$ x $3\frac{1}{2}$ ins.), already ventilated with two holes ($\frac{1}{2}$in. diam.) in the lids and long sides, were obtainable and were purchased. These were packed in four, strong, fibre-board cartons—12 tins per carton. Each carton measured 19 x 12 x 9 ins. and, including its empty tins, weighed 4 kilos. A maximum and minimum thermometer was placed inside one carton to record extremes of temperature. Each tin was capable of holding between 120 and 130 seeds of cocoa packed in layers of charcoal in the manner mentioned above. (Plate 1. Fig. 2.) One larger tin with ventilation holes (2 mms. diam.), and a thermos flask of 1 pint capacity were carried separately.

In order to keep the charcoal from leaking through the ventilation holes, these were covered with strips of muslin. The inside of each carton was also lined with muslin in a manner which would prevent the escape or entry of insects. The Plant Importation Regulations of India and Pakistan require that planting material carried by air must be in sealed boxes or packages protected by wire gauze or muslin.

Journey, Collection and Transport of the Seeds

On 19th November, 1949, 200 healthy pods were collected from the plot of cocoa trees, representative of the normal Amelonado cocoa grown in the Gold Coast, at the Botanic Gardens, Aburi. (Plate 1. Fig. 3). These trees are distant from virus infected areas and were free from virus diseases. The collection was supervised by the Director of W.A.C.R.I.*, Mr. O.J. Voelcker, and members of the staffs of the Institute and the Department of Agriculture, Gold Coast, who assisted the writer in surface-sterilising the pods and making them insect-free. Certificates of freedom from pests and disease were supplied and an export permit from the Customs Department obtained. These documents are necessary and should be obtained well before the expected time of departure of aircraft by anyone making a similar journey, otherwise there is every chance of being delayed at Accra and elsewhere. The pods, weighing 100 kilos., were carried in a clean sack in a pressurised locker of a York aircraft to Kano next day.

Packing the Seeds.

Between 8 a.m. and 4 p.m. on 21st November, the packing operation took place. The air at Kano was so dry that it was decided to increase the moisture content of the charcoal powder by mixing two parts of moist charcoal with nine of dry, instead of one to nine as planned. The seeds were so placed in the charcoal in the tins that, when the tins were packed in the cartons, the seeds would be carried the right way up, i.e., "pointed" ends up. This precaution was taken in case the seeds germinated *en route.* Two hundred seeds were packed in the larger tin with the moist charcoal,

* The West African Cacao Research Institute.

and 75 seeds were rolled in moist charcoal and placed in the thermos flask. This tin and the flask accompanied the writer as luggage—a precautionary measure in case the main consignment was held up for any reason. In two of the ordinary tins, the seeds were packed in damp "Vermiculite"—a form of mica produced in South Africa which has valuable insulating properties. This was supplied at the writer's request by South Africa House, London. Valuable assistance was given by the staff at the Department of Agriculture's Farm, at Kano, making it possible to complete the packing, labelling etc. in time to deliver the consignment to the airport and pass it through the Customs before the offices closed.

Transport of the Seeds.

The York aircraft was scheduled to leave Kano for Castel Benito at 6 p.m. on 21st November, but foggy weather in London had upset the normal time-table and no aircraft was available until 9 p.m. on the 22nd November, a delay which caused the writer some concern as the "bone-dry" atmosphere had dried the charcoal carried in the spare tin. Permission was obtained to inspect the tins in the cartons and a small quantity of water was added to each tin and the cartons were stored in a cool place under a tarpaulin.

Castel Benito was reached at 4 a.m. on 23rd November, and the cartons were stored in a warm room at the airport—70°F. in the room and 62°F. out of doors. Three days were spent here awaiting a plane to Cairo, as the time-table was still upset by the London weather. The days were warm (80°F.) and very dry but the nights were cool (62°F.). It was necessary to add small quantities of water to the charcoal which tended to cake and dry out. The maximum and minimum thermometer in the carton showed extremes of max. 90°F. min. 60°F.

Cairo was reached, by York aircraft, on 26th November, at 1.45 a.m. The days were dry and warm (79°F.) and the nights dry and cold (52°F.) during the 3½ days spent here. The cartons were kept near an electric light bulb (temperature 62 to 65°F.) in a room at the airport (Customs) warehouse. The seeds in the spare tin were kept warm under the writer's blanket, as the temperature in the bedroom dropped to 52°F. at night. Signs of germination were observed on the 27th November and the hypocotyls began to emerge next day, i.e., 7 days after the seeds were packed. (The seeds in the thermos flask did not germinate until after they were planted at Pulau Tekong; the hypocotyls emerged 13 days, and the cotyledons 18 days after the seeds were packed.) The thermos flask was opened in warm air (79 to 90°F.) for a moment daily during transport, in order to disperse CO_2. It is not known whether this procedure is necessary or not.

A Constellation aircraft became available at 7.30 a.m. on 29th November, 1949. There was room for the cartons in the passenger compartment and they remained there until Singapore was reached in the evening of 30th November. (Plate 2. Fig. 1). Details of air temperatures, inside and outside the aircraft, at different altitudes were kindly supplied by the pilot and are shown in Table III.

Table III.

Air Temperatures Recorded when Flying between Cairo and Singapore 29th to 30th November, 1949.

Temp. inside the aircraft.	Temp. outside the aircraft.	Altitude	Locality.
°F	°F	ft.	
—	59	ground	Cairo
67	20	15,500	Over Arabia
70	27	15,000	Over Pakistan
69	30	15,000	Over India
70	38	15,500	Over Calcutta
67	28	17,500	Over Siam
72	32	15,000	Over Penang

The Medical and Health officials at Karachi Airport tend to detain passengers from West Africa in quarantine unless in possession of a "flawless" International Certificate of Health giving full details of vaccination and of inoculation against yellow fever.

Condition of Seeds on Arrival.

Germination was 100 per cent. in all containers except the thermos flask, as already mentioned. The hypocotyls were from ¼ to 2½ins. in length; those of the seeds packed in Vermiculite were uniformly short, and those of 100 seeds from which the mucilage had been removed at packing, as an experiment, were uniformly long. It was fortunate that the precaution had been taken to carry the seeds the right way up, otherwise many of the hypocotyls would have been entangled and probably damaged at planting. The charcoal was barely moist in the tins and probably would have been too dry if the journey had lasted another two days. The Vermiculite was adequately moist and appears to be suitable for seed packing. The sample used was alkaline and it would probably be better to use a neutral sample for cocoa seed. Perhaps a mixture of charcoal and Vermiculite would be useful.

Planting the Seeds.

Owing to very wet weather at Pulau Tekong in November it had not been possible to prepare baskets, filled with potting soil, for the reception of the seeds and they were accommodated, temporarily, in beds of sand under shelter. Planting was completed on the evening of 2nd December, 1949. The charcoal, and the Vermiculite, was washed away from some of the seeds to observe if this treatment would be beneficial.

The soil at the nursery is variable. There are patches of very light, sandy "bris" and of a light, red-brown soil which, when mixed together, provide a mixture of suitable texture for cocoa seedlings. To this mixed soil, a mixture of cattle manure and "sludge" from septic tanks was added—one part of each to two parts of soil. This mixture was used as the potting soil (pH = 6.2; no carbonate present and only a trace of chloride). Small quantities of artificial manures were later given to the plants at

intervals during growth. Water for the nursery comes from a well (pH = 4.9 to 5.3; total soluble solids, chlorine, sulphate (SO_4) = 2.2; 0.66; 0.82 parts per 100,000 respectively). Planting baskets are made by local peasants from split rattan canes, prepared from the climbing palms (*Calamus* spp. etc.), and from bamboo. The baskets used when the seedlings were transplanted were 10 ins. deep x 9 ins. diameter at the top, with a flat base 6 to 7 ins. in diameter.

Notes on Growth.

Cotyledons appeared about 4 days after the germinating seeds had been planted in the sand beds, i.e., about 16 days after the seeds were packed in the tins. When the plants were six weeks old there was little difference between them. The treatments given, (i.e., removal of mucilage at packing, seeds in Vermiculite, seeds in charcoal, seeds with charcoal and Vermiculite removed at planting, seeds packed in the larger tin with small ventilation holes, and seeds in the thermos flask), did not appear to have affected the seeds in any way. There were, however, 130 plants from seeds planted upside down by accident; these plants were always backward.

The weather was mostly wet and windy in the North East monsoon, from December to the end of February, and tall screens were erected for lateral protection of the plants which were grown in baskets from mid-December until they were released from quarantine. In February and March the plants were transferred from the plant-houses to slat-roofed shelters for hardening off. (Plate 2. Fig. 2). This process should be done gradually and plants should not be moved into brighter surroundings until the youngest leaf flush is green. On the nursery site there are tall coconut palms, mango trees and bananas which assist in providing dappled shade and shelter from wind, and, in addition, creepers are being established on the expanded-metal fence surrounding the nursery. (Plate 2. Fig. 3).

At first, the baskets were kept on the ground until benches with thick wire-mesh platforms on angle-iron supports were obtained. Each bench holds 18 basketed plants and these are at a height convenient for the examination of individual plants. The benches are moveable and have been found very satisfactory. (Plate 2. Fig. 4). It is advisable to keep basket plants off the ground, otherwise the plants might root in the ground and be injured when lifted, and baskets do not deteriorate as quickly if they are not in contact with damp earth.

In February and March, at the end of the third flush, the plants had an average stem girth, at the base, of $\frac{5}{8}$ in. and were from 10 to 15 ins. tall with an average of 13 leaves per plant. (Plate 3. Fig. 1). In April and May the plants were given a clean bill of health and were sent to the Botanic Gardens, Singapore, after the completion of the fourth flush of leaf. About 5,300 plants were raised from the consignment of seed and of these 4,956 were released for distribution (Table IV).

Table IV.
Distribution of West African Amelonado Plants.

No. sent to Sarawak	No. sent to North Borneo	No. sent to the Fed. of Malaya	No. retained at Singapore	Total
538	570	3,649 +	199	4,956

+ 256 plants were later damaged during lorry transport or when being planted in the field.

About 350 plants were disposed of by burning on account of poor growth due to pest attack or the development of abnormalities, e.g., slow emergence from the cotyledon stage, twisted roots etc. The baskets were carried to the mainland in crates, (Plate 3. Fig. 2), nine baskets per crate, closely packed to prevent undue movement with consequent root disturbance. The Governments of North Borneo and Sarawak each sent an officer of the Department of Agriculture to care for the plants during the sea trip to Sandakan and Kuching. The plants went as deck cargo and were put into boxes having closed sides and slat tops. The plants destined for distribution in the Federation of Malaya were collected at intervals, by lorry, from the Botanic Gardens, Singapore.

Notes on Pests and Diseases.

Collar Rot.

In January, 1950, the fungus *Marasmius semiustus*, a facultative parasite on palms and other monocotyledons, developed fructifications on some of the baskets (Plate 3. Fig. 3). These had fleshy, yellowish or white caps on short stalks coloured orange-red towards the base; caps ¾ to 2 ins. diam., gills, attached from the edge of the cap, extend towards the stalk as long, short and shorter gills (resembling an inch measure divided into ¼ and ½ in.), spores numerous, hyaline, 7 to 10 x 5 to 6 microns. The mycelium of the fungus invaded the lumps of sludge in the potting soil mixture and spread to the collar of some of the seedlings, penetrated into the bark and wood, and killed the plants. It was found that many of the baskets had been carrying the mycelium on the split rattan and, for some weeks, action had to be taken to collect and destroy the fructifications, and to treat the baskets externally with fungicides to discourage production of fructifications. Fortunately the mycelium did not attack the roots of the plants, and it was possible to protect unaffected stems by spraying with Perenox—a fungicide based on copper oxide. It was possible to save plants attacked at the collar if the infection was discovered within two days after the threads of mycelium appeared on the bark. This mycelium is inconspicuous at first—merely a "bloom", greyish in colour—but at this stage is readily killed by Perenox, at a strength of 1 ounce in 2½ gallons of water, applied with a brush or as a spray. Several paintings at daily intervals are needed if the "bloom" has been allowed to develop into a "weft" of mycelium. Removal of pieces of sludge from contact with the base of the stem also helped to control this rather alarming disease. When the baskets were off the ground, in the

drier atmosphere of the wire benches, the fungus caused no further damage. Cultures were made from the mycelium on the stems, from infected cortex and from spores deposited from fructifications. Growth from each was identical and proved that *M. semiustus* was the cause of the disease.

It is difficult to prevent the development of fructifications on the baskets and it would be desirable to treat the baskets with a preservative fungicide before they are filled with soil. This fungicide should not be easily removed by water and should not have an injurious effect on feeding roots of seedlings. Experience with basket preservatives at the Federal Experiment Station, Serdang, indicates that Cuprinol in kerosene is useful but is likely to damage cocoa seedlings if the baskets are used soon after the preservative is applied. Untreated baskets tend to disintegrate in about four months if used in damp places. Treated baskets last much longer and do not quickly decay when placed in planting holes. This is not altogether desirable, as the roots may tend to be confined, but it is not difficult to cut away the base of such baskets when planting them.

Leaf Abnormalities.

The vein clearing and banding, typical of cocoa virus disease did not develop in any of the plants. A pale, scratched appearance in some leaves was due to sand splashed on to the underside of young leaves. A pallid appearance of the young flush was occasionally observed in plants exposed too quickly to a brighter overhead light. Some plants developed long, linear to lanceolate leaves; this was particularly evident in those with twisted stems, due to the seed having been planted upside down, and in plants which did not easily emerge from the cotyledons. When in the third and fourth flushes, some plants formed pale, broad, dentate or serrate leaves quite different from normal cocoa leaves. (Plate 3. Fig. 4). This has been found, at W.A.C.R.I., to be due to a combined deficiency of manganese and iron. Spraying with manganese sulphate and ferrous sulphate solutions effected a cure.

Insect Pests.

Certain pests gave trouble from the beginning but were kept in check by the use of insecticides and by hand collection in the day-time and at night. Grasshoppers (adult *Atractomorpha* sp. and nymphs) began to feed on the leaves but were not numerous after the grass and undergrowth surrounding the enclosure were cleared back a couple of chains and the ground dusted with Agrocide.

Beetles which eat the leaves were collected by hand during inspection rounds by the overseer, at 7 p.m. and 10 p.m. nightly. Occasional use of D.D.T. dust and Gammexane smoke generators also helped to control these pests, and damage was not severe. The following beetles were recorded as capable of damaging cocoa:—*Apogonia cribricollis*, *Lepadoretus* sp., *Autoserica* sp., *Anomala* sp., *Leucopholis rorida*, *Phytorus dilatatus*, *Nodostoma aeneipenne*.

Caterpillars were not often found and none were kept for identification. A common butterfly on the nursery was *Precis a. atlites*.

The most serious pests were a sucking bug *(Anoplocnemis phasiana)*, *Brachytrypes* sp. and mole crickets. Only two males of the sucking bug were captured but they had killed a number of seedlings in a few days. The crickets killed many young seedlings by injuring the bark just below the soil. It was found, however, that if the symptoms of damage were observed early—leaf droop was an indication—plants could be saved by cutting the stem across, above the injury, and, after clipping the leaves in half, planting the stem as a "cutting" embedded in a ball of cattle manure and soil kept moist. Even young seedlings, with soft, green stems, formed roots and recovered if so treated.

Coccids were not observed until March, 1950, when *Pseudococcus citri* was seen occasionally. Spraying with Shell White Oil was effective against these pests. A scale insect occurred on a few plants but was quickly parasitised by a black fungus and did no damage.

Summary.

An account is given of the arrangements made in connection with the introduction of Amelonado cocoa from the Gold Coast into Malaya; the collection, method of packing and transporting seeds of this variety by air is described. Mention is made of the precautions taken to ensure that certain diseases and pests, affecting cocoa in West Africa and not known in Malaya, were not introduced along with the seeds or in the packing. An account of the journey is given and details of the air and ground temperatures experienced on the route taken, are included.

The cocoa isolation nursery operated by the Department of Agriculture, Federation of Malaya, is briefly described and the progress made in the nursery by the imported seeds and the plants obtained from them is also mentioned. A total of 4,956 healthy plants of this variety was distributed to the Federation of Malaya, North Borneo and Sarawak.

A collar rot of the seedlings, due to the fungus *Marasmius semiustus*, is described along with the control measures adopted. Details are also given of the insect pests which were troublesome.

Acknowledgements.

The writer gratefully acknowledges the help received, while planning and executing this mission, from members of the staffs of the Office of the Adviser on Agriculture to the Secretary of State, and the Colonial Office; the Crown Agents for the Colonies; British Overseas Airways Corporation, W.A.C.R.I., the Departments of Agriculture, Gold Coast, Nigeria, Federation of Malaya and Singapore, and the Agricultural Adviser to The Commissioner General, South East Asia, the Gardens Department, Public Works Department and Department of Public Relations in Singapore.

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Figure 1.
PULAU TEKONG.

Figure 2.
Cocoa seed packed in ventilated tins. (Photo by Public Relations Department, Singapore)

Figure 3.
Pods being examined after collection at Aburi.

Figure 1.
Cartons of seed on arrival at Singapore.

Figure 2.
Plants in slatroof shelter. (Photo by Public Relation Dept., Singapore).

Isolation Nursery, Pulau Tekong. (Photo by Public Relations Dept. Singapore).

Moveable benches for basket plants.

Figure 1.
Amelonado cocoa plant. (Photo by Public Relations Dept., Singapore).

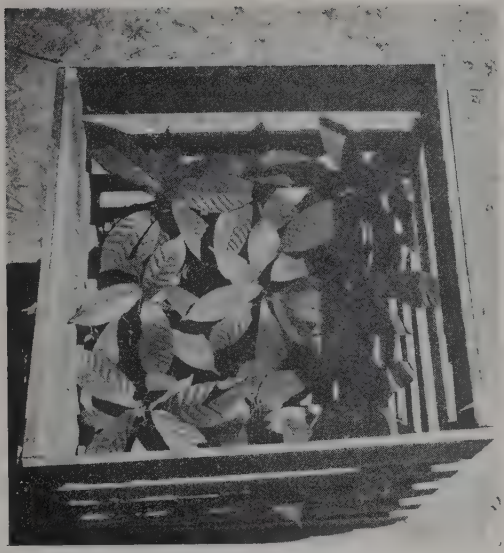

Figure 2.
Plants crated for despatch—lid removed. (Photo by Public Relations Dept., Singapore).

Figure 3.
Marasmius semiustus fructifications on a basket. (Photo by Public Relations Dept., Singapore).

Figure 4.
Abnormal leaves due to deficiency of iron and manganese.

A PASTURE ESTABLISHMENT EXPERIMENT IN MALAYA

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Introduction.

It has been generally agreed for a number of years that Malayan agriculture would benefit if the number of livestock could be increased and a system of mixed agriculture adopted on smallholdings. The feeding of livestock has, therefore, been the subject of several investigations. For many years the emphasis was on stall-feeding of fodder grasses but since 1938 more attention has been given to the possibility of improving local pastures. It was shown by observations and records, commenced in 1938, that under leguminous shade trees not only were higher yields obtained but the quality of the grass, as judged by its protein content, was considerably higher. (1). Marsh and Dawson in a series of articles on Animal Husbandry in Malaya have discussed the relative merits of pasture and cut fodders (2).

A pasture establishment and maintenance experiment was laid down at the Federal Experimental Station, Serdang, in 1940 but this did not survive the years 1942 to 1945 when Malaya was occupied by the Japanese, A more comprehensive series of experiments were laid down in 1947 and 1948, and the experiment described here was one in this series.

General.

The experiment was conducted on a field of about 5 acres at the Federal Experimental Station, Serdang. The soil was rather poor and of the transitional hill-quartzite—valley-quartzite type. The site was relatively level, with a gentle slope.

Early in 1948 the field was covered by a heavy growth of lalang *(Imperata cylindrica)* and it was decided that it should be converted to pasture under leguminous shade trees. Accordingly the area was cleared of lalang by mechanical cultivation (3) and shade tree seedlings *(Enterolobium saman)* were planted at a spacing of 40 x 40 ft. square.

The decision to lay down a pasture gave an opportunity to compare various methods of establishing pasture under local conditions. Ashby (4) has described the methods used to establish grazing grounds in Kelantan, and the experiment, described here, was designed after considering some of his problems and suggestions.

The grass used was the broad-leaved savannah grass (*Axonopus compressus*, Beauv.) as the earlier investigations, referred to above, suggested that this was the most promising permanent pasture grass under local conditions, particularly under light shade.

Objects of the Experiment.

The experiment was designed to

(1) compare (a) planting root divisions;
(b) natural establishment;
(c) seeding under a nurse crop of groundnuts,

(2) compare different planting distances in the plots planted with root divisions,

(3) compare areas weeded of annual weeds with those unweeded, and

(4) see to what extent early grazing or early mowing would assist establishment.

Difficulty was experienced in finding a source of *A. compressus* seed, and, when obtained, it eventually proved to be *A. affinis*. This error invalidates the conclusions regarding the seeded plots as *A. affinis* (carpet grass) is thought to be the more vigorous species under conditions of no shade (5). The shade trees were still too young and small to give any effective shade during the course of the experiment.

The Method Used in the Experiment.

The layout adopted was of six blocks, each comprising 5 main plots with each main plot split into 5 sub-plots. The size of each sub-plot was 40 x 40 ft., so that the young shade trees were located at the corners of all sub-plots.

The primary treatments (planting methods) on the main plots were:—

P1. Planting *A. compressus* root divisions at 1 x 1 ft.
P2. ,, ,, ,, ,, 2 x 2 ft.
P3. ,, ,, ,, ,, 3 x 3 ft.
U. Natural Establishment (neither seed nor root divisions planted).
S. Seeded with *A. affinis* under drilled groundnuts.

The secondary treatments (cultural methods) on the sub-plots were:—

A. Weeded of annual weeds.
B. Weeded of annual weeds and grazed early.
C. Unweeded and not grazed or mowed.
D. Unweeded and grazed early.
E. Unweeded and mowed early. The mown grass being left as a mulch.

Establishment.

The area was prepared for planting by mechanical cultivation between July and November, 1948, and given a dressing of 1 ton of lime per acre.

The root divisions and groundnuts were planted in November, 1948, and the *A. affinis* seed undersown on the groundnut plots in January, 1949.

The cultural operations i.e. hand-weeding and grazing, were carried out on the appropriate sub-plots at monthly intervals from January to July, 1949. (Six operations). The seeded plots under groundnuts could neither be grazed nor mown until March when the groundnuts were harvested. The groundnuts yielded at the rate of 950 lbs. of unshelled nuts per acre.

Lalang and *Mimosa pudica* were hand-weeded from all plots at monthly intervals during the establishment period.

In July, 1949, the plots were considered established and all the plots were mown and the produce carried off. The unweeded sub-plots (C) produced a heavy crop of herbs and grasses.

Records.

From September, 1949, to January, 1950, all plots were mown at monthly intervals (a total of 5 cuts) and the yield of each sub-plot estimated by weighing the produce from a 7 ft. strip across the sub-plot (40 ft.) The weight of produce included all species, whether palatable or not. As the proportion of unpalatable herbs was low it is considered that the weight of produce recorded gave a fair estimate of the value of the plots as pasture.

All species of weeds, other than *Axonopus* spp., were estimated by five line transects of 10 ft. in each sub-plot in July, 1949, when the pasture was considered established. Similar line transect estimations were made in March, 1950, after the end of yield recording.

Results of the Experiment.

The summarised total yields for five cuts are given in Table I.

Table I.

Total Yield of Produce from Six Blocks (5 Cuts between September, 1949, and January, 1950.) (Sample Strips 7 x 40 ft.)

Treatment	A	B	C	D	E	Total	Estimated lbs./acre (six months)
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
P1	295	211	331	258	348	1,443	7,482
P2	310	208	457	222	350	1,547	8,021
P3	303	182	289	229	341	1,344	6,969
U	200	228	329	202	281	1,240	6,429
S	346	286	433	359	360	1.784	9,250
Total	1,454	1,115	1,839	1,270	1,680	7,358	7,631
Estimated lbs./acre (six months)	7,539	5,781	9,535	6,585	8,711	7,631	—

Primary treatments:—

For significant difference between 2 totals of 30 sub-plots—305.7 lbs. (5 per cent.)

Secondary treatments:—

For significant difference between 2 totals of 30 sub-plots — 226.3 lbs. (5 per cent,).

The anlysis of the results shows that for primary treatments (planting methods).

S is better than P1, P3 or U, P2 is better than U; and for secondary treatments (cultural methods) :—

C and E, are better than A, D or B; and A is better than B, with significance at the 5 per cent. point in each case.

Randomisation placed two P2 plots on the southern border of the experiment. This was near an open drain and the figures from the plots

in the two blocks concerned (Blocks III and IV) were regarded with suspicion. Analysis of the remaining four blocks showed:—

S better than P1, P3, P2, or U; P1 better than U at 5 per cent.

This conclusion is considered more accurate and is accepted in the discussion which follows. In other respects the analysis of the four blocks separately gave substantially the same conclusions as the anlysis of all six blocks.

The analysis of the individual monthly cuts showed differences of the same order but with varying degrees of significance. The differences between the treatments were maintained until the last recorded cut in January, 1950.

The total figures of the weed estimations in July, 1949, are given in Table II.

Table II.

Total Number of Weeds Counted along Five 10 ft. lines (per sub-plot) in July, 1949 (6 Blocks).

	A	B	C	D	E	Total
P1	80	64	209	199	161	713
P2	115	83	450	221	203	1072
P3	129	90	344	226	237	1026
U	132	217	417	314	349	1429
S	106	117	427	354	336	1340
Total	562	571	1847	1314	1286	5580

For significant difference between primary treatments (totals) — 228 (1 per cent.)
For significant difference between secondary treatments (totals) — 200 (1 per cent.)

The analysis of total weeds in July shows that for primary treatments:—

U, S, contained more weeds than P2 or P3; and P2 and P3 contained more weeds than P1, and for secondary treatments:—

C contained more weeds than D or E; and E contained more weeds than B or A, with significance at the 1 per cent. point in each case. The figures for the estimates made in March, 1950, were substantially the same but with reduced significance.

Discussion.

(a) Planting Methods.

Planting Root Divisions.

There were no significant differences in yield between the plots planted with root divisions at 1 ft., 2 ft., and 3 ft. Weeds were reduced by close planting.

Natural Establishment.

Under the conditions of the experiment at Serdang the 'natural establishment' plots were only just significantly inferior to planting root

divisions, but there was a good growth of *A. compressus* in the surrounding area which may have acted as a source of seed. The natural establishment plots may not have done so well on a larger area.

Seed Plots.

The planting of root divisions is the traditional method of establishing grassland in Malaya but the experiment suggests that with suitable grass species and nurse crop, sowing seed may give equally good results with smaller labour requirements.

In this experiment the groundnuts just repaid the cost of planting and harvesting. When the groundnuts were harvested the soil was necessarily disturbed and the young grass seedlings growing near the rows of groundnuts were killed. Maize, another cereal, or soyabeans may make a better nurse crop.

The yields from the seeded plots were higher than any others but, as explained above, this may be because *A. affinis* was used and not because the plots were seeded. There was also a heavy growth of annual weeds on the soil which was disturbed by lifting the groundnuts. These weeds no doubt contributed subsequently to the yield of these plots.

(b) Cultural Methods.

Hand Weeding.

The differences between the cultural methods are significant. Hand-weeding certainly reduced the number of weeds. The yield of the hand-weeded plots was significantly reduced and there is no doubt that the pasture value of the plots was diminished. As weeding was the most expensive of the cultural treatments this is of interest.

Early Grazing.

Early grazing helped weed control in the plots which were not hand-weeded but also seriously diminished yields during the recording period. The cattle and buffaloes grazed not only the grass but also most of the herbs in the plots. This is some justification for including the herbs in the records of the produce from the plots. A separate experiment suggests that on well established pasture under shade, grazing may be beneficial. During establishment, however, grazing has here been shown to be detrimental.

Early Mowing.

Early mowing was the most effective cultural treatment. Whilst the plots were not as clean as the hand-weeded plots they were satisfactory pasture and yielded more than the hand-weeded plots or the unweeded plots grazed early. It should be noted, however, that whilst a certain amount of grass was grazed off the grazed plots no produce was removed from the mown plots, the cut grass being left as a mulch.

It appears therefore that once an area has been cleared, levelled, and planted with grass it is better to mow the area for a number of months than to carry out expensive hand-weeding or to permit too early grazing.

(c) General.

A total of 12 species of grass and 19 others were recorded on the line transects. The grasses included mainly *Paspalum conjugatum*, *Eragrostis* spp., *Eleusine indica* and, in Blocks III and IV, *Brachiaria distachya* and *Digitaria* spp. The 'natural establishment' plots however were invaded by *Axonopus compressus*, illustrating the natural vigour of this species under local conditions.

Soft annual weeds such as *Borreria latifolia*, *Ageratum conyzoides* and *Scopria dulcis* diminished during the recording period. Sedges such as *Kyllinga* sp. and *Fimbristylis diphylla* increased in frequency.

An attempt to correlate the weed species found with treatments gave no conclusions except that sedges were significantly more frequent on the plots planted with root divisions. No satisfactory explanation of this is apparent.

Conclusions.

1. Close spacing (1 x 1 ft.) of root divisions of *Axonopus compressus* did not give significantly greater yields than wide spacing. (3 x 3 ft.). Close spacing reduced the number of weeds.
2. Early grazing diminished later yields but assisted weed control in the unweeded plots.
3. Hand-weeding diminished yields but gave good weed control.
4. Early mowing increased yields and assisted in weed control.

Acknowledgements.

Acknowledgement is made to Mr. C. W. S. Hartley, Senior Agricultural Officer, (Research), who initiated the experiment and who was responsible for the design and layout.

Thanks are also due to members of the staff of the Federal Experiment Station, Serdang, for their help and co-operation, and to senior officers of the Department of Agriculture for helpful criticism.

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MECHANIZATION.

Quarterly Progress Report, July to September, 1950.

Compiled by the Acting Senior Agricultural Officer (Research) and the Agricultural Officer (Engineering).

Recent Importations.

The following tractors and implements were received during the period under review:—

Ferguson Tipping Trailer with automatic hitch.
Ferguson 2F disc plough EAE 20.
Ferguson Potato Spinner DHE 20.
Oliver TNT Sub-Soil Plough.
Ferguson Weed Master Sprayer.

Tests and Modifications.

Ferguson Implements.

The Ferguson Trailer arrived in chassis form at the beginning of the quarter and a strong body of conventional type was built by the Experimental Station carpenter. "Chengai" wood was used for the bed of the Trailer and mild steel runners were fitted. The side and tail board were made of "meranti", and the hinges were arranged so that the sides may be removed if required.

The automatic coupling device consists of a special hook mounted below the rear axle and connected to the hydraulic lift-arms in such a way that it can either pivot through a small arc or be mechanically locked in the raised position. When automatic coupling is desired this hook is lowered and made to engage, by reversing the tractor, with a ring at the end of the trailer drawbar. The hook is then raised and the mechanical lock automatically holds it in operating position.

Coupling and uncoupling with this device are very quick and exceptionally safe. The same type of unit is used with the Ferguson manure spreader, and drawbar rings are now being fitted to locally made water and liquid manure tanks. The automatic hitch can be particularly recommended where two or more trailers are served by one tractor.

The hydraulic tipping cylinder of the trailer is connected to a pressure-take-off point on the tractor by a flexible rubber hose and a self sealing joint. The pump has ample capacity for tipping heavy loads, but both raising and lowering of the body are fairly slow.

Since the trailer arrived at the Federal Experiment Station, Serdang, it has been used almost daily with the Ferguson TED 20 tractor. The trailer is equipped with rubber tyres and if properly licenced, can be used on public roads. Sand, laterite, oil palm bunches, planting material, labourers, engineering stores and many other loads have been carried on both good and bad roads. It was tested by driving across a slope with a top-heavy load of 15 cwts.: the trailer turned on its side at a slope of

about 1: 3 but the tractor remained upright and the only damage sustained was a broken side board.

Full loads can be towed, on level roads, in top gear at 13 m.p.h. and it is usually far more economical to use tractor and trailer than a lorry.

The Ferguson manure loader and spreader, received during the previous quarter, have not yet been fully tested. The spreader was tried with a load of very fresh, long-strawed dung but the shredding rotor became choked up and work had to be abandoned. It seems certain that only well-rotted, "short" dung will be suitable for mechanical handling.

The Ferguson disc terracer has been used near Kuantan to set up small water control "batas". It seems probable that the implement will prove suitable for this work.

Owing to shortage of staff it has not yet been possible to test the Ferguson Rotovator which arrived in June, or the sprayer, disc-plough and potato spinner which arrived in September.

The Danuser Digger.

The rate and cost of working on the Danuser Digger was recorded in the April, 1950 issue of this Journal. Since the end of March the machine has been in daily use at the Federal Experiment Station, Serdang, on quartzite soils and at the Federal Experiment Station, Port Swettenham, on coastal clays. The high rate of working and the low cost per hole have been maintained or, on occasion, bettered and the unit has proved extremely useful and economical, saving about 10 cents per hole when compared with hand labour.

Although a total of 39,000 holes have been dug in soils ranging from fairly soft to very hard, no trouble has been experienced except that on one occasion the helical flights of the auger broke away from the central axis and had to be re-welded. The replaceable cutting edges have periodically been rebuilt with mild steel filler rod and ground sharp, and some of the pivot pins in the framework have had to be replaced, but this was only to be expected in a machine working under such arduous conditions.

Transplanters.

Two transplanters were tested at the Federal Experiment Station, Serdang, during the period under review. They were tested with Guinea grass and Napier grass cuttings about 7 ins. long, but the trial was mainly concerned with the possibilities of the machines for padi planting.

The first machine to be tried, the Russell Multiplanter with Ritchie Easifeed attachment, was received from the manufacturers in Trailer form but, for convenience and accuracy of work, the fore-carriage was removed and transplanters mounted direct on to the Ferguson hydraulic lift linkage. The machine is made up of the desired number of single-row units mounted on a tool bar. Each unit consists of a stout steel frame on which are mounted a coulter, or furrow opener, and two conical presser wheels set on axles that are inclined to the horizontal. In the space between the presser wheels, and driven by them, are two sponge rubber discs that grip the cuttings, carry them forward and downward into the furrow made

by the coulter and, when properly adjusted, hold them in place until the presser wheels have packed the soil around the roots. An operator sits on a seat at the rear of each frame and feeds each unit with cuttings which are passed to her, from a tray, by an assistant who rides on a second seat near the front of the unit.

When using the Russell Multiplanter spacing of plants in the row is entirely dependant on speed of tractor and energy of operator. Using a Ferguson tractor and two Multiplanter units set 3 ft. apart the minimum possible speed was 0.7 m.p.h. and the average number of cuttings handled per operator 52 per minute, so that the average spacing was 14.2 ins. between plants. There was, however, very considerable variation in planting distance within rows and the spacing became progressively more irregular since operators were sitting in an uncomfortable position and soon became tired.

No breakdowns occurred during the test and indeed there are few parts liable to sustain damage under normal conditions.

The second machine to be tested was the Robot Transplanter, a trailer single-row machine suitable for most tractors, but used in this case behind a type 7.7 Fordson Major tractor.

This transplanter consists of a rigidly built chassis with furrow-opener and presser wheels mounted to one side. An endless chain, on which are mounted special spring loaded fingers, passes over a table in front of the four operators, who place cuttings between the fingers as they are opened by stationary cams. The endless chain then carries the cuttings down the side of the machine and drops them in the furrow made by the coulter.

Spacing within the row is controlled by a variable drive to the endless chain and a fairly wide range of settings is available. Spacing does not depend very much on the operator, who sits in a comparatively comfortable position. Four operators can supply cuttings fast enough for 1 ft. planting with the tractor travelling at 1.6 m.p.h. At this speed each handles 35 plants per minute.

There was a greater variation in planting depth with the Robot than with the Multiplanter, and the cuttings were less well pressed into the soil with the former machine.

The Multiplanter, with its simplicity and light weight is likely to be more suitable for padi work than the more complicated Robot.

The Allman "Midget" Knapsack Duster.

The Allman Midget is a small engine-driven duster designed to be carried by the operator. The hopper, which contains about 20 lbs. of dust and is provided with an agitator, a screen and a control slide, is carried on the back, while the 34 c.c. 2-stroke air-cooled engine and fan are carried on the chest.

The duster has been tested in Province Wellesley for the application of Hormone weed killers to wet padi. It was found that by removing the screen from the base of the hopper a satisfactory rate of application could be obtained but the duster was too heavy and cumbersome to be handled by one man under wet conditions. The unit was, therefore, bolted to a

light framework and either carried by two men or mounted on the mud-guard of a tractor.

Reconditioning worn Plough Shares.

During August an experiment was made, with the co-operation of Industrial Gases (Malaya) Ltd., into the possibilities of reconditioning worn out plough shares. A very badly worn share from a Ferguson 2-furrow plough was selected and the eroded metal replaced with mild steel filler rod. When the original shape had been restored the tip was covered with three beads of a medium grade Stellite filler and a single bead of the same material was run along the wing for about 5 ins.

The finished share, which was rather blunt and bulbous in appearance, was placed on the front body of a 2-furrow Ferguson plough and a new share placed on the rear body. This implement has only been in use for eight hours but the reconditioned share appears to be satisfactory in all respects. The rate of wear is being recorded.

The cost of reconditioning one share, including mild steel and Stellite B filler rods, labour and gas was under $2.00. The technique employed is described and illustrated in the Technical Information Paper No. 15 issued by the British Oxgen Company.

Rust Prevention.

Rust on an agricultural implement not only increases its depreciation but may also greatly decrease its efficiency. It has been frequently demonstrated, for example, that rust on the body of a plough will greatly increase the draught, while rusty blades on a cutter bar will not cut grass.

The best and most permanent protection against rust is a good quality paint but, whilst this is excellent for the frame of an implement and the chassis of a tractor, it is not suitable for the bright parts of machines during storage.

A recent trial at the Federal Experiment Station, Serdang, has given valuable information on the problem of storage of machines and the use of rust preventives. Briefly it has been shown that it is best to store machinery in a covered shed but that, in the absence of a roof, it is better to leave it in an open space rather than in the field. Even under cover, bright metal surfaces were covered with a light layer of rust within 36 hours but grease or waste engine oil will give adequate protection to machines left in the field overnight or over a week-end.

For periods of from a week to a month oil was completely unsatisfactory when applied to implements in the open, since the surface layer of oil hardened and cracked and water penetrated to the surface of the metal. Grease also hardened and cracked, but gave partial protection. Although oil and grease were found to give fairly satisfactory protection to metal parts stored under cover, in the open the only satisfactory rust preventative used was one of the proprietary fluids marketed by a large oil company. After application of this fluid the solvent evaporates and leaves a thin impervious film over the surface of the metal. This film protects the metal during storage and handling but soon wears away when the implement is used.

Investigations into Wet Padi Cultivation.

Coastal Clays.

In Province Wellesley a mechanical cultivation trial at Bukit Indra Muda was harvested in July and August. The area had been planted earlier than most of the padi in the neighbourhood and suffered heavy damage from pests and birds, but there was little variation in yield. The crop was as heavy on plots that had merely been rolled prior to planting as on those that had been ploughed to 9 and 12 ins. All the plots required weeding 3 weeks after planting and all received 50 katis of rock phosphate per acre.

Off-season crops on a deep versus shallow ploughing trial at Malacca have been harvested and cultivation and planting of the padi crop completed. Groundnuts and sweet potatoes showed little variation in yield between treatments, but the yield of green manure (*Crotalaria anagyroides*) was 100 per cent. better with 8-inch than with 4-inch ploughing.

A drilling trial at Malacca was abandoned as the drilled seed failed to germinate except where the land was dry.

The crop of groundnuts in a cultivation and off-season experiment on a clay soil near Kuantan was extremely poor. Sweet potatoes, green gram and dwarf cow peas were also tried but failed owing to inadequate drainage.

Investigations into Dry Land Cultivation.

MECHANICAL OPERATIONS PREPARATORY TO PLANTING.

Coastal Clays.

Mechanical work on an estate drainage experiment in Selangor is almost complete. The area has been cleared of rubber stumps and vegetation and the drains for the experiment dug, but to prepare 30 acres for planting has been extremely difficult, and would probably have been impossible if the weather had not been exceptionally dry.

The first ditches were cut with a Ransome ditcher pulled by a winch as described in the April, 1950 issue of this Journal. When the land had dried out sufficiently to carry heavy equipment a system of ditches were dug with a Cuthbertson H type ditcher pulled by a Caterpillar D-8. This implement proved quite successful, its disc coulters cutting through old roots and its cable lift easy to control. The final clearing and deepening of the ditches was done with the Killefer 35R ditcher, also pulled by a D-8 tractor.

Muck Soils.

The Cuthbertson F ditcher and the Killefer 35R have also been used on a muck soil. The ditches were unsatisfactory in both cases since, when the surface peat was wet, the tractors could not move and, when it was dry, the soil would not scour and the ditch was not cleaned properly.

Inland Soils.

A terracing experiment, to be hedge planted with rubber, has been started in Johore. Narrow terraces are being made by a D-4 with a hydraulic angle dozer and different methods of cultivation are being tried.

NOTES ON CURRENT INVESTIGATIONS, JULY TO SEPTEMBER, 1950

Compiled by the Acting Chief Research Officer and the Senior Agricultural Officer (Research).

Padi.

Additional varieties of padi have been included in the collections at the Experiment Stations at Kota Bahru (Kelantan), Pulau Gadong (Malacca), and Titi Serong (Perak), making the total number of varieties 931. In the analysis of the results of the 1949-50 variety trials it was in many cases possible to review the results of a 3 year period. Where significant differences in yield were then shown, the 1950-51 variety trials were re-designed to test other varieties or new selected strains. The first season of ear-row selection of Acheh Puteh was completed at Panchang Bedina, Selangor, but was a complete failure at Sungei Burong in the same district, where all the 750 lines were lost by flood. The progressively reduced selection lines of Serendah Kuning (Negri Sembilan), Nachin (Malacca), Radin Ebos (Kedah), Mayong Sa-Batil (Penang), Siam (Malacca) and Seraup (Krian) have been sown.

The programme of manurial and cultivation experiments for the 1950-51 season, to which reference was made in the previous quarterly notes, along with botanical trials and selection, are engaging all the padi stations in the country. A die-back of padi which selectively affected the variety Milek Kuning 3 in West Pahang in 1949 appeared again in 1950. Plans to investigate the cause of the isolated failure of this previously successful variety had been made, including applications of various fertilisers before and during growth of the padi. As in 1949, no causative parasite could be detected on affected plants. The season's experimental work on dry padi includes 7 agronomic experiments at Melor Padi Test Station, Kelantan. The results of all the agronomic experiments on padi in 1949-50 have been analysed and are summarised separately.

Cocoa.

Trinitario.

Selection has been completed on the plots at Serdang and Cheras, and recording is still continuing. The remaining Departmental plot of mature trees at Temerloh Agricultural Station, which has hitherto been used as a source of seed for establishment experiments, commenced to be surveyed in more detail for the purpose of selection. Controlled pollination, selfs and crosses, amongst the Serdang and Cheras selections has produced about 30 progenies which are to be planted out for a comparative trial. The second clonal trial, for which over 800 rooted cuttings have been accumulated, is to be planted in a field already prepared at Serdang, bearing established shade of *Adenanthera pavonina.*

Criollo.

Collection of budwood from kampong trees for the purpose of budding available Trinitario stocks at Serdang has continued. There is difficulty in getting the buds to shoot as the stocks are rather too large and the budwood not ideal, but already 60 kampong trees are represented by successful buddings. Illegitimate seedling progenies from 40 of the trees have so far been raised and basketed. They will be planted out in a field of unwanted oil palms, which will serve as temporary shade until they are cut out.

Amelonado.

In the variety trials against selected and unselected Trinitario, Amelonado has shown at least as vigorous growth as the other plants, and is possibly more tolerant of lack of shade. Growth has been very good in most localities where the trials were put down. At Serdang it is satisfactory to note that with applications of fertiliser, the growth of cocoa in general is good on the rather poor hill quartzite soils.

Many specimens of dying cocoa plants from various parts of the country were examined from the pathological point of view, but among the various apparent causes of injury there was nothing to excite concern. The plants reported in the July, 1950 issue of this Journal to have grown well in nutrient solution not containing potash were nevertheless found to contain potash when chemically analysed, the amount being half that found in plants which grew in nutrient solution containing potash. The unforeseen source of potash was evidently the sand aggregate which supported the roots, and in future experiments steps will be taken to eliminate potash from the sand to be used. Some of the Amelonado seedlings in the Pulau Tekong nursery were detained because they developed serrated chlorotic leaves, but they became normal after spraying at intervals with ferrous sulphate and manganese sulphate. Injection with iron remedied chlorosis in leaves but manganese did not have a similar effect.

A variety of cases of insects injuring cocoa was investigated but the only cause of widespread damage is *Apogonia* or allied beetles and, to a smaller extent, grasshoppers. Such damage can be kept under control by regular spraying, and four months' observation of weekly spraying with six different insecticides has shown lead arsenate and Accotox to be the two most effective. Considerable success in suppressing *Apogonia* has been obtained with Agrocide.

Oil Palm.

It is still found that in an area of neglected palms, groups of palms are healthier and the fruit better, whatever fertiliser is applied, whether nitrogen alone, phosphate alone, or potash alone. Progeny rows of palms at Serdang after a complete manuring have begun to show an improvement in appearance without as yet a change in the mineral composition of their leaves. In the growing of oil palm seedlings in nutrient solutions of different pH values it has been found that increasing the magnesium content of the solution renders the plants more tolerant of higher pH.

Further cases of leaf rot of seedlings and young palms have been examined, and it seemed probable that the predisposing cause was unsuitable soil conditions. No evidence has been discovered for the presence of a vascular wilt.

Tea.

Clonal tea selection proceeded to the stage of planting cuttings of 580 field selected bushes at Serdang, and rooting is satisfactory subject to the expected variation. The field selection of 260 bushes at Cameron Highlands has been completed. A second trial on methods of packing tea seed confirmed that moist coconut fibre was the best packing material for the preservation of viability of the seed. In connection with export of tea seed, all difficulties as to viability are solved by air transport if there are no delays or obstructions in transit. A commercial consignment to Kenya which arrived in 14 days gave 100 per cent. germination. The seed which had been treated with the organic mercurial preparation "Agrosan" was packed in air-dry charcoal powder.

Blister Blight has now been reported on all tea holdings at Cameron Highlands. There is some evidence of difference in susceptibility or resistance amongst tea plants which will influence clonal selection. Other fungi growing in association with *E. vexans* in blisters have been isolated and their possible influence is being investigated. Attempts to infect tea seedlings from sporulating blisters in an artificial climate at Kuala Lumpur were not successful. Trials of copper fungicides at Cameron Highlands are having satisfactory results, and experiments have been started at Tanah Rata Agricultural Station to investigate

(a) Variation in the incidence of Blister Blight in different months of the year.
(b) Incidence of Blight as affected by time of pruning, by spraying and by manuring with a potassic manure.
(c) Comparison of different sprays and spraying intervals.

Coconuts.

Additional records of endosperm and oil content were made, preparatory to final selection of palms for breeding. The experiments on drainage and cultivation combined with grazing amongst coconut palms at Port Swettenham Experiment Station are proceeding.

Soya Beans.

Imported Java strains have been grown for selection, and the best will be included in trials with previous selections of local and other imported varieties.

Fibres.

A sufficiently prolonged period of dry weather allowed rapid progress to be made in preparing the land at Port Swettenham Experiment Station for the cultural and manurial experiment with Manila hemp. All work including digging the planting holes was done by machinery. When this was finished there was unfortunately an enforced delay in planting, for the

long awaited dry spell made condition so very dry that it was necessary to wait for rain.

The trial of six varieties of Manila hemp at Serdang has remained unsatisfactory probably on account of unsuitability of site. The varieties Tangongan and Serdang "C" show some promise, although Serdang "B" gives the heaviest yield from its large number of short stems.

Jute grew very well on a muck soil at Sungei Burong on the Selangor coast. Preparations were made to sample the crop at harvest for experiments on extraction of fibre and determination of fibre yield. In the fibre collection at Serdang only *Hibiscus sabdariffa* and *Hibiscus macrophyllus* so far have made satisfactory growth. Unexpected discoveries of Mauritius hemp plants are likely to permit this species being brought into the collection for trial.

The manurial trial of ramie on peat at Jalan Kebun, Selangor, is showing a marked response to N P K fertilisers which is not in keeping with the result of earlier trials.

Fodders.

In the factorial experiment in manuring Guinea grass at Serdang the most important result so far is the marked linear response to nitrogen and potash and the absence of response to phosphate. A comparative trial of grasses has given significant results, the best yield being from Napier grass with Guatemala grass second and Guinea grass third. *Stylosanthes gracilis* has given outstanding growth as a leguminous fodder, and planting material is being distributed to Agricultural Stations. Ladino clover which showed such great promise at Cameron Highlands has suffered very severely from die-back due to causes not yet fully ascertained.

Pasture.

Work continues on a series of long term experiments at Serdang. Records were continued of soil temperature under *Axonopus* grass, in shade and exposed to full sunlight. Mechanical and chemical methods of eradicating *Mimosa pudica* continue to be tested.

Pineapples.

Suckers from healthy and unhealthy plants in an area affected by pineapple wilt in Johore were planted in Kuala Lumpur in 1949, but all the plants were invaded by mealybug, and both groups displayed the same incidence of wilt. Detailed examination of plants in Johore revealed the uselessness of attempting to correlate wilt symptoms with visible mealybug attack, for the insects penetrate to the lowest part of the leaves and also to the roots. Tests of a proprietary insecticidal dust containing a supposed systemic phosphorus insecticide showed that it was harmless to the plant and killed all mealybug *Pseudococcus brevipes* with which it came in contact within 24 hours, but had no effect on insects protected from contact, even after four weeks. Further experiments are being conducted on pineapple plants to which ingress of mealybug is excluded.

A manurial experiment has been laid down near Klang on young pineapples interplanted between rubber hedges.

Soils.

Peat.

An examination was made of peat in an old river valley between hills of quartzite in Selangor. There were not the large timbers common in coastal peat but apart from a high alcohol soluble fraction the chemical composition was very similar to that of coastal peat.

Sulphur content.

A number of padi soils from Penang and Province Wellesley contained from 0.26 to 1.12 per cent. of sulphur. There was no relation between sulphur content and padi yielding capacity, and the good areas in Penang had high values. Experiments were made on the leaching of sulphates from soils, in which daily leaching for a period alternated with drying out for a period. In soils which had originally a high sulphate content the great proportion was soon removed, but a small sulphate content was removed very slowly and there was not usually an increase in the rate of extraction after a drying period. Other experiments on sulphur containing soils showed a very large increase in the amount of sulphate leached after treatment with hydrogen peroxide. The relative slowness of oxidation of sulphur compounds in soil under conditions of simple aeration and the slowness of leaching illustrate the need for good drainage and aeration in ameliorating soils subject to sulphate acidity.

The clay fractions from various padi soils from Penang and Kedah were tested by the hydrometric method for particle fineness. There were no outstanding differences, and in general the soils with the highest clay fraction contained the highest proportion of that fraction in the form of very small particles.

Conductivity measurements of suspensions of soils from a large number of points on both upland and swamp areas have been made, and the results show that there are important differences. There are prospects of much useful information emerging from this work, particularly in detecting abnormal soils. The electrical resistance of buried blocks of plaster of Paris was applied to the measurement of soil moisture in a preliminary investigation of the movement of water in relation to drains in the clay at Port Swettenham Experiment Station. The presence of soluble salts in reducing the resistance is likely to complicate the measurements.

Soil surveys were made for specific reasons in certain areas, notably land for experiment Stations, new padi areas and new cultivation of other kinds. The soil samples examined from the Trans-Perak Padi Scheme covered all types from sands to deep peats.

Canning Research.

The very extensive rehabilitation of the Research Station at Johore Bahru and the installation of necessary new equipment is approaching completion, and basic measuring apparatus has been checked and calibrated. The demonstration cannery will be able to perform most operations envisaged in connection with the local industry. Work on quick freezing of pineapple was seriously impeded by frequent electric power failures. Priority has

been given to improving the existing scheme for examining and grading canned pineapple. Methods have been devised and tested to make the grading more accurate and workable.

Detailed advice has been given to canners on the proper methods of operating existing mechanical equipment and on the installation of new equipment. Co-operation with canners in their factories yields information which is of the greatest value for the Research Station and the future development of the industry.

Livestock.

Poultry.

A feeding and management experiment has been laid down at six centres. Rhode Island Red and local fowls are being tested under two types of management, and fed with two types of ration. An experiment has been started at Cheras Agricultural Station to determine whether fertility and hatchability of eggs can be improved by feeding an increased amount of animal protein and varying the number of hens per cock.

Pigs.

Heavy culling has been carried out in the selections at Serdang.

Goats.

Four pure-bred, three three-quarter bred and eight half-bred kids were born during the quarter. Since kidding, a British Alpine has averaged 6.3 lbs. of milk per day, a Toggenburg 5.6 lbs., and a local Nubian type 4.8 lbs.

Departmental Notes.

Appointment.

Mr. E. W. Bewlay has been appointed to be an Agricultural Development Officer with effect from 1st January, 1950. Mr. Bewlay is stationed at the Federal Experiment Station, Serdang, Selangor.

Transfers.

Mr. E. J. H. Berwick, Agricultural Officer, has been appointed to act as State Agricultural Officer, Kelantan and Trengganu, with effect from the 22nd August, 1950.

Leave.

Mr. H. K. Ashby, State Agricultural Officer, Kelantan and Trengganu, has been granted 152 days leave, in addition to voyages, with effect from the 25th August, 1950.

Mr. E. F. Allen, Agricultural Officer, returned from leave on the 8th August, 1950, and has been appointed to act as Senior Agricultural Officer (Research).

Mr. R. J. A. W. Lever, Entomologist, returned from leave on the 17th September, 1950, and has resumed duty at Headquarters.

Mr. L. N. H. Larter, Botanist, returned from leave on the 1st October, 1950, and has resumed duty at Headquarters.

MARKET PRICES

July to September, 1950.

Rubber.—The Singapore price of No. 1 R.S.S., f.o.b., in tables, buyer, during the third quarter of 1950 increased to 156 cents per lb. by the 25th September, and on the last day of that month was 146½ cents per lb.

The price on the 1st July, 1950, was 78¼ cents per lb. increasing to 119½ cents on the 31st and giving an average price for July of 94.01 cents per lb. August opened with the price at 122½ cents increasing to 171 cents by the 8th and dropping to 128 cents by the 31st, giving an average price of 133.37 cents per lb. During September the price increased from 131½ cents on the 1st to 156 cents on the 25th. The average price for the month was 146.24 cents per lb.

The average prices paid for smallholders' rubber at three centres in the Federation of Malaya during the third quarter of 1950 are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, July-September, 1950.

(Dollars per picul of 133⅓ lbs.)

Grades	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	July.	Aug.	Sept.	July.	Aug.	Sept.	July.	Aug.	Sept.
Smoked Sheet ..	122.50	161.50	173.50	117.50	159.70	175.65	100.75	143.75	166.25
Unsmoked Sheet ..	107.50	151.00	140.00	102.00	133 20	148.00	93.00	133.38	152.13
Scrap ..	40.00	53.50	45.00	44.00	49.00	55.00	27.40	27.69	41.88

Transport from Batu Pahat to Singapore by lorry, excluding duty, 80 cents per picul.

Tea.—The average price paid in Colombo for Malayan tea, as quoted in the Colombo Brokers' Association weekly report dated 19th September, 1950, was Rs. 2.22 per lb. The average prices of Ceylon teas quoted in the weekly report dated 10th October, 1950, were as follows, in rupees per lb.: High Grown Teas Rs. 2.75, Medium Grown Teas Rs. 2.31, Low Grown Teas Rs. 2.22.

Ceylon teas are subject to an export duty but non-Ceylon teas sold at auctions ex-bond in Colombo for re-export are not subject to this duty.

The retail price for Malayan Tea (Boh) continues to be $2.25 per lb.

Palm Oil.—The majority of Malayan estate production of this commodity continues to be sold to the United Kingdom Ministry of Food. There has been no change in the price payable to producers of £74 per ton f.o.b. Singapore. The 5 per cent. *ad valorem* Malayan export duty is for sellers' account.

Derris.—The price of this commodity as quoted in the weekly reports of the Singapore Chamber of Commerce increased to $110 per picul on 8th August, and remained steady at $100 throughout September, 1950.

Tobacco.—The average prices paid per picul for cured leaf in Kelantan during the third quarter of 1950 were as follows:—1st quality $550, 2nd quality $378 and 3rd quality $175.

Rice. The ration of rice continues to be 3½ katis per person per week. Rice can now be purchased in three grades at the following prices per picul: High Grade $33, Medium Grade $26 and Low Grade $22.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil*	Pepper. F.A.Q. Muntok white	Pepper. Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1950								
3rd July ..	33.00	56.50	760.00	770.00	65.00	18.00	17.50	15.00
10th July ..	36.00	57.50	855.00	865.00	66.00	18.50	17.50	15.00
18th July ..	36.75	61.00	985.00	995.00	66.00	21.00	17.50	16.00
24th July ..	37.25	61.00	1025.00	1035.00	66.00	19.50	18.25	16.00
8th Aug. ..	40.50	72.00	1030.00	1040.00	68.00	20.00†	18.75	17.00
14th Aug. ..	41.50	70.00	1025.00	1035.00	68.00	21.00	18.75	17.00
21st Aug. ..	42.25	69.00	990.00	1000.00	68.00	21.00	18.75	17.00
28th Aug. ..	44.50	71.00	1010.00	1020.00	70.00	21.00	18.50	17.50
5th Sept. ..	46.50	76.00	1030.00	1035.00	70.00	21.00	18.50	17.50
11th Sept. ..	45.75	74.00	1015.00	1020.00	70.00	22.00	18.00	17.50
18th Sept. ..	46.00	75.00	1000.00	1010.00	70.00	21.50	18.00	16.50
25th Sept. ..	42.50	73.50	1010.00	1020.00	70.00	20.50	18.00	16.50

*F.O.B. †Nominal

The above prices are taken from the weekly report of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1949	1950	1949	1950
January ..	3,798.0	3,958.5	799.9	896.0
February ..	4,007.0	3,643.1	821.4	969.9
March ..	4,055.6	4,860.6	860.1	1,184.0
April ..	3,999.3	4,918.5	808.3	1,249.0
May ..	4,120.9	4,433.0	809.2	1,086.3
June ..	4,321.5	4,226.4	791.2	1,070.0
July ..	4,461.3	4,360.6	931.0	1,069.5
August ..	4,398.2	4,585.9	906.0	1,192.5
September ..	4,234.9	4,084.7	858.9	1,095.4
October ..	4,125.5		875.3	
November ..	4,504.3		994.1	
December ..	4,539.2		1,004.0	
Total ..	50,560.7	(39.071.3)	10,459.4	(9,812.6)

In September 48 estates (planted area 89,083 acres) were in production out of a total of 54 oil palm estates (planted area 91,362 acres).

MALAYAN AGRICULTURAL EXPORTS, APRIL-JUNE, 1950.

Product	Net Exports in Tons.			
	Year 1948	Year 1949	Apr.-June. 1949	Apr.-June. 1950
Arecanuts	6,043	5,607	2,226	1,503
Coconuts fresh†‡ ..	44,887†	21,971†	7,759†	12,758†
Coconut oil‡	45,245	60,504	15,746	12,381
Copra‡	28,625*	24,424*	6,272*	24,079††
Copra cake	12,176*	27,643*	10,362*	6,282*
Gambier, all kinds ..	286	293	119	143
Palm kernels	6,462	8,744	2,194	2,655
Palm Oil	46,821	55,211	10,987	12,232
Pineapples, canned ..	4.073	8,130	1,644	4,955
Rubber¶	696,978¶	670,257¶	151,264	160,209
Sago,—flour	16 946*	1,476	1,053	2,008
„ —pearl	19,084	3,477	644	275
„ —raw	6,667*	1,317*	435*	3,331*
Tapioca,—flake	304	737	258	343
„ —flour	1,999*	278*	299	1,120*
„ —pearl	14,263	12,345	4,120	3,185
Derris	80	48	16	647
‡Copra equivalent ..	45,795	74,334	19,470	20,639

¶ production (Federation of Malaya). † hundreds in number. * net imports.
†† Includes Tons 5,625.23 being Federation shipments from January to May omitted from previous statements.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1949	1950	1949	1950	1949	1950
January ..	36,397	35,237	24,052	26,440	60,449	61,677
February ..	27,593	27,297	17,450	22,645	45,043	49,942
March ..	33,616	27,789	20,309 14,113†	21,688 476†	53,925 14,113†	49,477 476†
April ..	28,142	26,667	16,744	22,409	44,886	49,076
May ..	33,570	30,870	18,499	25,898	52,069	56,768
June ..	32,921	31,196	18,683 2,705†	23,169‡	51,604 2,705†	54,365‡
July ..	35,751	34,547	20,137	30,947	55,888	65,494
August ..	36,658	33,316	20,504	29,307	57,162	62,623
September ..	33,828	30,323	24,900*	28,514 5,924†	58,728*	58,837 5,924†
October ..	30,788		20,096		50,884	
November ..	35,169		23,825		58,994	
December ..	35,576		23,977 4,254†		59,553 4,254†	
Total ..	400,009	(277,242)	270,248	(237,417)	670,257	(514,659)
Total 1948 ..	402,907		294,071		696,978	

Smallholding production is estimated from purchases reported by dealers.

† Quarterly adjustment.

* Includes quarterly adjustment (deduction of 822 tons).

‡ Includes quarterly adjustment (deduction of 3,370 tons).

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1949	1950	1949	1950	1949	1950	1949	1950	1949	1950
January ..	2,476	2,577	7,406	7,765	9,882	10,342	4,727	5,501	3,245	3,634
February ..	2,605	2,662	5,544	6,868	8,149	9,530	4,429	4,831	3,027	3,182
March ..	2,644	3,064	4,981	7,062	7,625	10,126	4,638	5,774	3,211	3,798
April ..	2,755	3,002	6,203	7,367	8,958	10,369	4,832	4,847	3,325	3,201
May ..	3,039	3,424	5,884	10,160	8,923	13,584	4,995	6,507	3,437	4,341
June ..	3,500	3,761	6,723	9,109	10,223	12,870	5,607	6,373	3,756	4,176
July ..	3,838	3,767	6,915	9,158	10,753	12,925	5,710	5,962	3,870	3,938
August ..	3,867	3,580	8,676	9,916	12,543	13,496	5,671	6,315	3,858	4,222
September ..	3,651	3,581	9,256	12,593	12,907	16,174	6,282	6,503	4,190	4,168
October ..	2,778		7,745		10,523		5,440		3,711	
November ..	3,035		9,332		12,367		5,736		3,871	
December ..	2,769		7,315		10,084		5,631		3,799	
Total ..	36,957		85,980		122,937		63,698		43,300	

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

FEDERATION OF MALAYA RICE STATISTICS.
SUMMARY OF ACREAGES AND PRODUCTION — SEASON 1949-1950.

STATE/ SETTLEMENT	TOTAL WET AND DRY PADI.									
	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Yield of Padi (5)		Rice Production (6)	
(1)	acres	per cent. of total	acres	per cent of (2)	acres	per cent of (2)	gantangs (000'S)	per cent. of total	tons	per cent. of total
Perlis ..	47,530	5.1	—	—	47,530	100.0	21,374	7.7	33,660	7.7
Kedah ..	288,550	31.3	3,260	1.1	285,290	98.9	115,871	42.2	182,480	42.2
Kelantan ..	172,860	18.7	620	.4	172,240	99.6	42,055	15.3	66,230	15.3
Trengganu ..	59,010	6.4	—	—	59,010	100.0	14,908	5.5	23,480	5.5
Penang & P.W.	40,600	4.4	210	.5	40,390	99.5	10,732	3.9	16,900	3.9
Perak ..	127,900	13.9	6,310	4.9	121,590	95.1	27,944	10.2	44,000	10.2
Selangor ..	48,550	5.3	1,820	3.8	46,730	96.2	11,592	4.2	18,250	4.2
Pahang ..	45,500	4.9	4,270	9.4	41,230	90.6	8,130	2.9	12,800	2.9
N. Sembilan ..	34,060	3.7	140	.4	33,920	99.6	10,998	4.0	17,320	4.0
Malacca ..	32,360	3.6	2,630	8.1	29,730	91.9	7,568	2.8	11,920	2.8
Johore ..	23,970	2.7	500	2.0	23,470	98.0	3,626	1.3	5,710	1.3
Total	920,890	—	19,760	2.1	901,130	97.9	274,798	—	432,750	—
Off-season crop			440	4.6	9,200	95.4	1,966		3,090	
Total 1949-50			20,200	2.2	910,330	97.8	276,764		435,840	
Total 1938-49	908,070		69,100		838,970		195,063		307,180	

Acreage to nearest 10 acres
Rice production to nearest 10 tons
Conversion Rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent).

Federation of M
Summary of Acreages and Pr
We

State/Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Ave Padi (5)	
	acres	per cent. of Total	acres	per cent. of (2)	acres	per cent. of (2)	gantangs	pe o for
Perlis ..	47,320	5.5	—	—	47,320	100.0	451	
Kedah ..	282,470	32.8	3,260	1.2	279,210	98.8	411	
Kelantan ..	141,800	16.5	610	.4	141,190	99.6	259	
Trengganu ..	47,830	5.5	—	—	47,830	100.0	272	
Penang & P. Wellesley	39,700	4.6	210	.5	39,490	99.5	268	
Perak ..	122,810	14.3	6,270	5.1	116,540	94.9	234	
Selangor ..	48,190	5.6	1,610	3.3	46,580	96.7	248	
Pahang ..	44,090	5.1	4,270	9.6	39,820	90.4	200	
Negri Sembilan ..	34,050	3.9	140	.4	33,910	99.6	324	
Malacca ..	32,320	3.7	2,630	8.1	29,690	91.9	255	
Johore ..	21,730	2.5	430	2.0	21,300	98.0	163	
Total	862,310		19,430	2.3	842,880	97.7	314	
Off-Season Crop	9,160		420	4.6	8,740	95.4	220	
Total 1949-1950	871,470		19,850	2.3	851,620	97.7	314	
Total 1948-1949	842,450		67,270		775,180		241	

Acreage to nearest 10 acres.
Rice production to nearest 10 tons
Conversion Rate: 635 gantangs paid = 1 ton rice (i.e. milling recovery = 63 per cent.)

aya Rice Statistics.
duction — Season 1949 — 1950
Padi

age Yield per Acre			Yield of Padi (7)		Rice Production (8)		Remarks (9)
	Rice (6)						
cent. av. eason	lbs	per cent. of av. for season	gantangs (000's)	per cent. of Total	tons	per cent. of Total	
43.6	1,591	143.6	21,327	8.0	33,590	8.0	
30.8	1,450	130.8	114,729	43.3	180,680	43.3	3,260 acres destroyed by drought, rats, floods and insects.
82.4	914	82.4	36,549	13.8	57,560	13.8	330 acres abandoned due to late planting; 200 acres destroyed by flood; 80 acres destroyed by sea-water.
86.6	959	86.6	13,017	4.9	20,500	4.9	
85.3	945	85.3	10,586	3.9	16,670	3.9	210 acres destroyed by floods, pests and disease.
74,5	825	74.5	27,295	10.3	42,980	10.3	6,270 acres destroyed by floods, pests and disease.
78.9	875	78.9	11,572	4.4	18,220	4.4	1,610 acres destroyed by floods.
63.7	706	63.7	7,970	3.1	12,550	3.1	3,770 acres destroyed by floods; 500 acres destroyed by pests.
03.1	1,143	103.1	10,998	4.1	17,320	4.1	110 acres destroyed by drought and lack of weeding; 30 acres damaged by pests.
81.2	900	81.2	7,561	2.9	11,910	2.9	2,630 acres destroyed by pests and floods.
51.9	575	51.9	3,470	1.3	5,460	1.3	430 acres destroyed by pests and floods.
	1,108		265.074		417,440		
	776		1,920		3,020		
	1,108		266,994		420,460		
	850		187,130		294,690		

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1950.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak ..	91.6	73.2	82.4	95	70	87	76			3.16	80.3	1.44	9	9	3			202.65	6.75	
Port Swettenham, Selangor	90.0	73.2	81.6	93	71	84	76	86.1	85.8	2.35	59.7	0.70	10	10	3	2		189.85	6.33	
K. Lumpur, Selangor ..	90.6	73.6	82.1	93	72	87	75			5.23	132.8	2.16	15	10	6	3				
Sitiawan, Perak ..	90.4	73.3	81.9	93	71	85	76			0.95	24.1	0.40	8	5	1			193.10	6.44	
Kuala Lipis, Pahang ..	89.0	72.5	80.7	92	69	85	75	85.0	84.9	5.18	131.6	1.26	16	12	4	25		176.05	5.87	
Kuantan, Pahang ..	90.7	72.6	81.7	94	70	86	75			8.27	210.1	1.58	16	15	6	6		167.80	5.59	
Temerloh, Pahang ..	90.7	73.1	81.9	93	70	88	76			5.41	137.4	2.25	13	13	1	5		169.05	5.63	
Bayan Lepas, Penang ..	87.9	75.1	81.5	91	72	84	81			6.50	165.1	2.28	12	11			1	191.60	6.39	
Malacca ..	86.2	74.2	80.2	89	71	84	79			2.33	59.2	0.76	14	11				216.90	7.23	
Mersing, Johore ..	87.9	72.5	80.2	91	70	84	74			9.17	232.9	1.39	15	15	7		2	193.30	6.44	
Alor Star, Kedah ..	88.4	74.5	81.5	91	72	83	77			3.17	80.4	1.12	11	9				182.90	6.10	
Kota Bharu, Kelantan ..	89.0	74.5	81.7	92	73	85	77	86.9		3.86	98.0	1.30	15	13	6			215.60	7.19	
K. Trengganu, Trengganu	88.7	73.4	81.1	92	71	84	76			5.03	127.8	2.31	16	14	7			198.75	6.63	
Kallang Aerodrome (S'pore)	87.6	76.1	81.9	90	72	82	81			2.77	70.4	1.53	13	6	3		3	186.90	6.23	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	74.8	63.2	69.0	78	61	71	65	72.7		5.43	137.9	1.64	15	12	2	6		171.55	5.72	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	73.6	56.0	64.8	78	51	69	62	68.8	70.7	3.76	95.5	1.33	20	10				157.35	5.25	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JULY, 1950

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak ..	91.6	71.1	81.3	96	68	87	74			7.29	185.2	2.92	13	11	5		1	204.25	6.59	
Port Swettenham, Selangor	89.6	71.9	80.7	93	68	82	75	85.6	86.1	1.13	28.7	0.40	10	7	1	6		202.25	6.52	
K. Lumpur, Selangor ..	89.8	72.1	80.9	94	69	82	75			2.17	55.1	0.46	11	8	2					
Sitiawan, Perak ..		72.0			70		75	84.5		1.75	44.5	0.58	11	8	1			209.15	6.75	
Kuala Lipis, Pahang ..	87.6	70.8	79.2	91	67	84	73	84.0	84.5	7.98	202.7	3.28	13	11	1	29		180.20	5.81	
Kuantan, Pahang ..	89.8	71.0	80.4	95	68	80	74			7.29	125.2	4.37	13	10	3	6		197.90	6.38	
Temerloh, Pahang ..	90.0	71.2	80.6	93	69	85	74			3.48	88.4	1.55	8	5	1	1		205.55	6.63	
Bayan Lepas, Penang ..	87.5	73.4	80.5	90	71	81	75			4.30	109.2	1.10	14	9	2		2	196.80	6.35	
Malacca ..	84.6	73.0	78.8	88	69	78	76			14.67	372.6	3.52	19	15	4			195.90	6.32	
Mersing, Johore ..	87.2	71.6	79.4	91	69	82	74			4.92	125.0	1.36	14	11	3			209.65	6.76	
Alor Star, Kedah ..	87.8	73.1	80.5	92	70	78	76			14.83	376.7	3.07	17	14				202.40	6.53	
Kota Bharu, Kelantan ..	88.9	73.4	81.1	91	71	86	75	87.1		1.71	43.4	1.24	9	6	1			201.15	6.49	
K. Trengganu, Trengganu	87.9	72.4	80.1	92	69	83	75			1.70	43.2	0.44	9	8	3	1	1	195.45	6.30	
Kallang Aerodrome (S'pore)	86.3	76.4	81.3	90	72	81	81			7.18	182.4	2.62	12	11	3	—	1	197.05	6.36	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	74.1	62.0	68.1	77	69	66	64	71.7		5.59	141.7	1.49	16	13	2	11		190.80	6.15	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	73.2	53.7	63.5	77	49	69	60	68.1	70.3	7.80	198.1	1.65	14	12	1	1		161.85	5.22	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1950.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall									Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days						Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more				
										ins.	mm.	ins.							hrs.	hrs.	
Ipoh, Perak ..	91.4	71.5	81.5	96	68	85	74			6.16	156.5	2.00	12	10	4	1	1		212.90	6.87	
Port Swettenham, Selangor	89.5	72.2	80.9	93	69	84	74	85.4	86.4	5.77	146.6	2.32	17	12	4	3			196.80	6.35	
K. Lumpur, Selangor ..	89.2	72.0	80.6	93	68	82	75			11.04	280.4	2.30	19	16	5	3					
Sitiawan, Perak ..	90.1	72.2	81.1	94	69	85	75	84.9		3.12	79.3	1.30	15	11	2				212.55	6.86	
Kuala Lipis, Pahang ..	88.5	71.0	79.7	92	68	83	74	84.1	84.6	10.71	272.0	2.18	13	11	1	25	1		190.35	6.14	
Kuantan, Pahang ..	90.3	71.3	80.8	93	68	86	75			7.93	201.4	2.15	17	12	3	5			205.20	6.62	
Temerloh, Pahang ..	90.4	70.7	80.5	93	69	88	73			4.27	108.5	1.27	12	12	2	3			199.60	6.44	
Bayan Lepas, Penang ..	86.8	74.2	80.5	90	71	80	77			7.69	195.3	1.81	15	14	2		1		196.35	6.33	
Malacca ..	84.6	73.5	79.1	87	71	82	79			13.48	342.4	4.58	20	16	1				209.05	6.74	
Mersing, Johore ..	86.8	71.3	72.1	91	68	82	73			6.08	154.4	1.34	12	12	3		1		197.95	6.39	
Alor Star, Kedah ..	87.8	73.6	80.7	91	71	83	76			9.51	241.6	2.66	17	14	2				223.25	7.20	
Kota Bharu, Kelantan ..	88.6	73.4	81.0	94	70	80	76	87.8		5.36	136.1	1.11	14	11	1	1			245.35	7.91	
K. Trengganu, Trengganu	88.2	72.1	80.1	92	69	81	75			4.02	102.1	1.30	12	8	7				215.40	6.95	
Kallang Aerodrome (S'pore)	85.7	75.6	80.7	89	71	81	80			10.89	276.6	3.86	18	14	2	—	—		158.65	5.12	
HILL STATIONS.																					
Fraser's Hill, Pahang 4268 ft. ..	74.0	61.6	67.8	77	60	71	63	72.1		10.05	255.3	23.5	18	16	2	11			188.35	6.07	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.5	55.3	63.9	76	48	69	60	68.5	70.3	8.74	222.0	1.47	21	19		3			160.95	5.19	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, SEPTEMBER, 1950.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes								Number of days								
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more		Total	Daily Mean	Per cent.
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak ..	90.5	72.5	81.5	95	70	82	75			7.03	178.6	3.10	15	12				161.60	5.39	
Port Swettenham, Selangor	89.5	72.9	81.2	93	70	80	75	85.6	85.9	4.30	109.2	1.09	15	12	1			167.25	5.57	
K. Lumpur, Selangor ..	89.4	72.4	80.9	94	69	80	74			5.18	131.6	3.06	12	9	4	2				
Sitiawan, Perak ..	89.9	72.7	81.3	93	71	84	75	84.7		3.97	100.8	1.09	11	6	2			169.55	5.65	
Kuala Lipis, Pahang ..	87.8	71.6	79.7	91	69	83	74	83.7	84.4	7.95	201.9	1.77	14	13	5	25	—	146.05	4.87	
Kuantan, Pahang ..	89.6	71.7	80.7	93	69	86	75			7.65	194.3	1.48	15	14	3	8	—	143.25	4.77	
Temerloh, Pahang ..	89.3	71.4	80.6	93	69	87	74			3.13	79.5	0.84	14	12	—	1	—	140.40	4.68	
Bayan Lepas, Penang ..	86.8	74.2	80.5	91	71	82	77			20.26	514.6	7.31	16	15	4		1	162.50	5.42	
Malacca ..	85.2	73.8	79.5	89	71	81	80			12.63	320.8	2.38	20	19	3			171.90	5.73	
Mersing, Johore ..	87.7	72.1	79.9	91	70	84	74			5.44	138.2	1.54	15	14	5		1	164.40	5.48	
Alor Star, Kedah ..	86.4	73.4	79.9	90	70	79	77			12.81	325.4	2.51	17	16			1	154.35	5.15	
Kota Bharu, Kelantan ..	87.4	74.2	80.8	90	70	85	77	85.2		5.20	132.1	1.16	12	10	6	1	—	144.30	4.81	
K. Trengganu, Trengganu	87.2	72.7	79.9	91	70	84	75			5.19	131.8	1.28	20	16	11	1	1	138.90	4.63	
Kallang Aerodrome (S'pore)	86.1	75.5	80.8	89	72	81	80			5.01	127.3	1.57	17	11	1	—	2	159.30	5.31	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	74.4	61.3	67.9	77	58	71	63	71.7		7.73	196.3	1.26	22	15	3	8	—	132.90	4.43	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.2	56.7	64.5	76	52	66	61	68.8	70.1	9.28	235.7	1.65	19	17	1	—	—	126.40	4.21	

Compiled from Returns supplied by the Malayan Meteorological Service.